Engineering faculty members' beliefs and practices in a technologically equipped classroom

Lara Hagenson Toney Niles
Iowa State University

Follow this and additional works at: https://lib.dr.iastate.edu/rtd

Part of the Curriculum and Instruction Commons, Instructional Media Design Commons, and the Online and Distance Education Commons

Recommended Citation
Niles, Lara Hagenson Toney, "Engineering faculty members' beliefs and practices in a technologically equipped classroom" (2007). Retrospective Theses and Dissertations. 15889.
https://lib.dr.iastate.edu/rtd/15889

This Dissertation is brought to you for free and open access by the Iowa State University Capstones, Theses and Dissertations at Iowa State University Digital Repository. It has been accepted for inclusion in Retrospective Theses and Dissertations by an authorized administrator of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.
Engineering faculty members’ beliefs and practices in a technologically equipped classroom

by

Lara Hagenson Toney Niles

A dissertation submitted to the graduate faculty in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Education (Curriculum and Instructional Technology)

Program of Study Committee:
Niki Davis, Major Professor
Ann Thompson
Dale Niederhauser
Ana Correia
Larry Genalo

Iowa State University
Ames, Iowa
2007

Copyright © Lara Hagenson Toney Niles, 2007. All rights reserved.
# TABLE OF CONTENTS

LIST OF FIGURES ............................................................................................................... vi

LIST OF TABLES ................................................................................................................ vii

ACKNOWLEDGEMENTS .................................................................................................... ix

ABSTRACT ............................................................................................................................ xi

CHAPTER I. INTRODUCTION ............................................................................................. 1

  Problem Statement ....................................................................................................... 8
  Objectives for this Study ............................................................................................ 9
  Research Question ....................................................................................................... 9
  Context ........................................................................................................................... 9
  Methodology ................................................................................................................ 10
  Research Approach ..................................................................................................... 10
  Significance of the Study ........................................................................................... 11
  Summary ...................................................................................................................... 12
  Structure of the Dissertation ...................................................................................... 12

      Chapter 1. Introduction .................................................................................. 12
      Chapter 2. Literature Review ......................................................................... 13
      Chapter 3. Methodology ................................................................................ 14
      Chapter 4. Findings from the First Case Study .............................................. 14
      Chapter 5. Findings from the Second Case Study ......................................... 15
      Chapter 6. Discussion, Implications, and Recommendations ...................... 15

CHAPTER II. LITERATURE REVIEW ............................................................................... 17

  Introduction ................................................................................................................ 17
  Methodology .............................................................................................................. 17
  Faculty Preparation .................................................................................................... 18
      Teacher Beliefs ....................................................................................................... 21
      Teacher Knowledge .............................................................................................. 29
      Teacher Practice ................................................................................................... 31
  Faculty Pressures and Roles ...................................................................................... 32
  Faculty Adoption of Technology ............................................................................. 34
  Strategies for Planned Change .................................................................................. 39
  Teacher Beliefs and Practice .................................................................................... 45
      Studies That Assumed Teachers’ Practice from Teachers’ Beliefs ................. 45
      Studies That Did Not Report Teaching Practice Based on Espoused Beliefs ... 58
      Studies That Examined the Relationship Between Espoused Beliefs and Teaching Practices ................................................................. 59
  Summary .................................................................................................................... 63
CHAPTER III. METHODOLOGY ........................................................................................................ 65
Introduction .................................................................................................................................... 65
Research Approach ....................................................................................................................... 66
The Participant Researcher and Engineering Distance Education ............................................. 68
Methods of the First Case Study .................................................................................................... 72
  Data Collection Methods and Participants .................................................................................... 73
  Semi-Structured Interview and the EBI .......................................................................................... 75
  Focus Group and Off-Campus Student Interview ........................................................................ 78
  Observations .................................................................................................................................. 78
Items Addressed Before the Second Case Study ......................................................................... 79
The Second Case Study ................................................................................................................ 80
  Data Collection Methods and Participants .................................................................................... 80
  Semi-Structured Interview and the EBI .......................................................................................... 82
  On-Campus Student Interviews and Off-Campus Student Phone Interviews ................................ 84
  Observations .................................................................................................................................. 85
Methods for Analysis of the Two Case Studies ............................................................................ 86
  Stage 1: EBI ................................................................................................................................. 86
  Stage 2: Course Objectives .......................................................................................................... 87
  Stage 3: Approaches to Teaching .................................................................................................. 89
  Stage 4: Course Objectives, Approaches to Teaching, and Teaching with Technology .................. 92
  Stage 5: Phenomena of Dr. K’s and Dr. J’s Teaching with Technology ........................................ 93
Ethical Considerations .................................................................................................................. 94

CHAPTER IV. THE FIRST CASE STUDY: DR. K ........................................................................... 96
Introduction .................................................................................................................................... 96
The Engineering Faculty Member, Dr. K ....................................................................................... 96
Dr. K’s Espoused Beliefs ................................................................................................................. 99
  EBI Results .................................................................................................................................. 99
  Course Objectives ....................................................................................................................... 101
  Students’ Active Connections with Course Objectives ............................................................... 102
  Approaches to Teaching .............................................................................................................. 104
  Approaches to Learning ............................................................................................................... 106
  Desired Learning Outcomes of the Course .................................................................................. 108
Dr. K’s Teaching, Including His Use of Technology ..................................................................... 109
  Dr. K’s Course ............................................................................................................................. 109
  Classroom Observations ............................................................................................................ 114
The First Case Study’s Findings ................................................................................................. 121
  The Phenomenon of Dr. K’s Espoused Beliefs and His Classroom Practices Using Technology ...... 121
Vignette of Dr. K ........................................................................................................................... 123
### Table of Contents

- **What Is It That You Teach to Your Students?** .............................................. 124
- **What Must Your Students Know?** ................................................................. 125
- **How Will Your Students Be Brought into Active Connections with That Knowledge?** ................................................................................... 125
- **Teacher’s Observed Practice** ..................................................................... 128
- **Teacher’s Approaches to Teaching with Technology** ................................... 129
- **Teacher’s Reflection on Practice** ............................................................... 130
- **Dr. K Compared to Dr. Leon** ......................................................................... 130
- **Summary** ........................................................................................................ 133
- **Proposed Improvement for Research of a Second Case Study** ................. 133

**CHAPTER V. THE SECOND CASE STUDY: DR. J** ................................................. 135

- **Introduction** .................................................................................................. 135
- **The Engineering Faculty Member, Dr. J** ................................................... 135
- **Dr. J’s Course** .................................................................................................. 137
- **Dr. J’s Espoused Beliefs** ............................................................................... 141
  - **EBI Results** ................................................................................................ 141
  - **Course Objectives** ...................................................................................... 141
  - **Students’ Active Connections with Course Objectives** ......................... 144
  - **Approaches to Teaching** ........................................................................... 148
  - **Approaches to Learning** ............................................................................ 151
  - **Desired Learning Outcomes of the Course** .............................................. 153
- **Two Contrasting Projects or Papers** ............................................................. 155
  - **Are the Projects or Papers Different for Off-Campus Students** ............. 157
- **Dr. J’s Teaching, Including His Use of Technology** .................................... 157
  - **Classroom Observations** .......................................................................... 157
  - **The Second Case Study’s Findings** ............................................................ 180
  - **The Phenomenon of Dr. J’s Espoused Beliefs and His Classroom Practices Using Technology** ......................................................... 180
- **Vignette of Dr. J** ............................................................................................ 181
  - **What Is It That You Teach to Your Students?** ........................................ 183
  - **What Must Your Students Know?** ............................................................ 183
  - **How Will Your Students Be Brought into Active Connections with That Knowledge?** ................................................................................... 184
  - **Teacher’s Observed Practice** .................................................................. 185
  - **Teacher’s Approaches to Teaching with Technology** .............................. 186
  - **Teacher’s Reflection on Practice** ............................................................. 187
  - **Dr. J Compared to Dr. Davis** ..................................................................... 187
  - **Summary** ...................................................................................................... 191

**CHAPTER VI. DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS** ............ 192

- **Introduction** .................................................................................................. 192
- **Faculty Espoused Beliefs and Classroom Practices** .................................. 193
- **Faculty Teacher Preparation on Their Beliefs and Practices** ....................... 197
LIST OF FIGURES

Figure 4.1. A Diagram of the EDE Classroom where Dr. K and Dr. J Taught.........................111
LIST OF TABLES

Table 3.1. Timeline for the First Case Study Research with Key Events for the Course and Research ................................................................. 74

Table 3.2. Data Collection Methods, Sources, and Instruments for the First Case Study. ............................................................................................................ 75

Table 3.3. Timeline for the Second Case Study Research with Key Events for the Course and Research. ............................................................................................ 81

Table 3.4. Data Collection Methods, Sources, and Instruments for the Second Case Study. ............................................................................................................ 82

Table 3.5. Shraw et al.’s (2002) Hypothesized Beliefs used for the EBI............................... 88

Table 3.6. Categories of Description for the Object of Study used in this Study .................. 90

Table 3.7. Categories of Description for Approaches to Teaching used in this Study........... 93

Table 4.1. The Mean Score for each EBI Category for Dr. K.............................................. 100

Table 4.2 The Number of Students Enrolled in Dr. K’s Course, according to Gender and On/Off-Campus Students ............................................................................. 112

Table 4.3. Similarities and Differences (Causal Links) Between Dr. K’s Espoused Beliefs and Classroom Practices Using Technology........................................... 122

Table 4.4. The Fit Between Dr. K’s and Dr. Leon’s Espoused Beliefs and Teaching with Technology .................................................................................................. 132

Table 5.1. The Number of Students Enrolled in Dr. J’s Course, according to Gender and On/Off-Campus Students ............................................................................. 140

Table 5.2. Student Demographics for the Second Case Study ............................................. 140

Table 5.3. The Mean Score for each EBI Category for Dr. J ............................................... 142

Table 5.4. Similarities and Differences (Causal Links) Between Dr. J’s Espoused Beliefs and Classroom Practices Using Technology ........................................... 182

Table 5.5. The Fit Between Dr. J’s and Dr. Davis’s Espoused Beliefs and Teaching with Technology .................................................................................................. 189

Table 6.1. A Summary of the Two Faculty Members’ Epistemic Beliefs, Espoused Beliefs, and Approaches to Teaching ......................................................................... 194
Table 6.2 Faculty Members’ Pedagogical Views and Approaches to Teaching, with Evidence from Classroom Observations .................................................. 201

Table 6.3. Pedagogical Roles of the Faculty, the EDE Staff Members, and the Students.... 205
ACKNOWLEDGEMENTS

The completion of this dissertation was a great challenge and an adventure. I felt as though I was on a long and interesting journey that left me striving for improvement, yearning for new adventures, inspired by findings, and rewarded with a great accomplishment. I thank God for his grace, mercy, and guidance; my faith in him gave me the courage and strength to keep moving forward. I would first like to express my deepest appreciation and gratitude to my major professor, Dr. Niki Davis, for her time, commitment, support, encouragement, and long-term efforts in guiding me to be a scholar and professional in academic research. She has shown me patience and has taught me to continually persevere through hard times and not so hard times. Most of all, she has always believed in me.

I would also like to express my gratitude and appreciation to the members of my committee, Drs. Larry Genalo, Ann Thompson, Ana Correia, and Dale Niederhauser, for providing many valuable recommendations, advice, and comments that improved the contents of this dissertation. For the support and friendship of the Engineering Distance Education unit for giving me time off when I needed to work, an ear to listen when times were rough, and encouragement when I become the slightest bit discouraged; and my colleagues in the CTLT who helped me relax by initiating getaways from my research and for providing support during the good and the bad times. I thank you all for being an important part of my life; I will never forget any of you.

My parents taught me perseverance and the value of education. They always believed in me and gave financially so that I could keep moving forward. I am in their deepest debt
and can only hope that I can give to them as much as they have given to me. Thank you for being the best parents a woman could ask for in life.

My husband, Brandon, has always believed that I would complete my Ph.D. Through all the hardships and adventures I have learned that love is never-ending and that patience is essential; thank you for learning with me. I thank you for your encouragement, love, and push to complete the largest document I have ever written. My sister, Leigh, who is always there when I need a shoulder, thank you so much for your support and guidance. Last but not least, I would like to thank the rest of my family who have provided me with an abundance of love and encouragement during my dissertation journey; you all are very special to me and I thank you for being a part of my journey.
ABSTRACT

Engineering programs continually strive to improve offerings in higher education, including the application of technology to increase access for adult learners who cannot attend on-site because they are professionals working in the field. Although, engineering faculty members are under pressure to improve their teaching, including both content and pedagogy, faculty beliefs and practices about teaching may or may not be consistent with their behavior during instruction. This research examined two engineering faculty members’ espoused beliefs and classroom practices (including the use of technology) in the teaching of two different engineering courses in a College of Engineering’s distance education unit. The research began with epistemology and provided a non-dualistic, phenomenographic perspective of engineering faculty using case study research, because as Merriam (1998) noted each phenomenon examined was intrinsically bound to one engineering faculty member. The data were analyzed using two theoretical frameworks, the Epistemological Beliefs Inventory (Schraw, Bendixen, & Dunkle, 2002) and instruments adopted and modified from Martin, Prosser, Trigwell, Ramsden, and Benjamin (2000). The two rich case studies matched two of Martin et al.’s categories and illustrated: the fit between faculty espoused beliefs and classroom practices, the influence of faculty preparation for teaching, the influence of faculty pedagogical beliefs on their course delivery with technology, and the pedagogical roles of the faculty and the engineering distance education staff. This research found that one engineering faculty member’s espoused beliefs were a good fit with his classroom practices using technology, whereas the other member of faculty (who had less preparation for teaching) appeared to have less coherence between his teaching approaches and course management techniques.
CHAPTER I
INTRODUCTION

Engineering programs are one of the many areas in higher education that continually strive to enhance the teaching process and students’ learning by implementing various instructional techniques and innovations with technology:

For the last two centuries, engineering as a practice has affected and has been affected by trends in politics, society, economics, and technology . . . the . . . engineer has always been influenced by the past, continues to shape the present, and will affect the future (Sheppard, Colby, Macatangay, & Sullivan, 2006, p. 430).

Recent efforts have included programs “to prepare a diverse cadre of engineers, increased accountability about how effectively engineering programs prepare engineering students, and an interest in preparing engineers to function in a global community with ethical and professional responsibilities” (Turns, Atman, Adams, & Barker, 2005, p. 27).

A review of the literature found that engineers need to design products and projects that keep in mind the possible benefits to the environment and humanity; be engaged in engineering work as employees of corporations, members of project teams, members of the broader societal and professional communities, and as individuals; be engaged in engineering work that involves a variety of formal and informal written and oral communication; and be engaged in practice that involves the integration of knowledge and process to solve problems (Sheppard et al., 2006; also addressed in Chadha & Nicholls, 2006). “Furthermore, because engineering is only one among many disciplines that drive technological implementation, interdisciplinary learning experiences that engage
disciplines beyond engineering will encourage professional practice” (Cooper, 2007, p. 294).

In an ideal university setting, the educational practices integrate practical skills [i.e., problem solving], ethical judgment, and knowledge “and thereby serve as an apprenticeship to the profession. This apprenticeship should guide the novice towards the acquisition of cognitive and practical skills, and the development of a sense of professional and personal responsibility” (Sheppard et al., 2006, p. 430). The integration of real-world problems is “certainly more difficult to implement in a classroom setting than are typical textbook problems and not so easily assessed. However, these real-world problems can engage students in deeper cognitive processes more akin to those of practicing engineers” (McKay & McGrath, 2007, p. 36). Nevertheless, the decisions made by faculty and administrators about instructional strategies and innovations with technology “must be submitted to those most qualified to render judgment—i.e., the students” (Serow, 2000, p. 460)—to ensure that students are prepared for their future job opportunities and career paths.

A review on engineering addressed the need for quality jobs in America (Augustine, 2005). There was a “unanimous view . . . that America today faces a serious and intensifying challenge with regard to its future competitiveness and standard of living. Further, we appear to be on a losing path” (Augustine, ¶4). Augustine acknowledged that: …without quality jobs our citizens will not have the purchasing power to support the standard of living which they seek, and to which many have become accustomed; tax revenues will not be generated to provide for strong national security and healthcare; and the lack of a vibrant domestic consumer market will
provide a disincentive for either U.S. or foreign companies to invest in jobs in America (¶5).

He supported these findings with current examples from the job market. For example, if a company in India were to hire, they could hire 11 engineers for the price of 1 engineer in the United States (¶20) and “five qualified chemists . . . for the cost of just one in America” (¶12).

This report made clear that “given the enormous disadvantages in labor cost, we cannot be satisfied merely to match other economies in those areas where we do enjoy strength; rather we must excel . . . markedly” (Augustine, 2005, ¶12). Therefore, it was recommended by his committee that the “Best and Brightest” initiative be integrated in higher education to “ensure that America does in fact share in the prosperity that science and technology are bringing the world” (Augustine, ¶22). This prosperity initiative, reported by Augustine, recommended that areas of higher education:

- Establish 25,000 competitive science, mathematics, engineering, and technology undergraduate scholarships and 5,000 graduate fellowships in areas of national need for U.S. citizens pursuing study at U.S. universities;

- Provide a federal tax credit to employers to encourage their support of continuing education;

- Provide a one-year automatic visa extension to international students who receive a science or engineering doctorate at a U.S. university and provide automatic work permits and expedited residence status if these students are offered employment in the U.S.;
• Institute a skill-based, preferential immigration option; and

• Reform the current system of “deemed exports” so that international students and researchers have access to necessary non-classified information and research equipment while studying and working in the U.S.

The report concluded with Augustine stating that, “if we wish our children and grandchildren to enjoy the standard of living most Americans have come to expect, there is only one answer: We must get out and compete” (¶24).

A review on curricular change found that:

…the next generation of engineers will need to be trained in the context of sustainability with an international perspective if they are to participate in solving problems of sustainability at the local and global scale . . . [and] to succeed in the global economy. (Hokanson, Phillips, & Mihelcic, 2007, p. 254-255)

The authors indicated that “some countries are facing a severe crisis that could have a far-reaching future impact. Simply stated, in some parts of the world (e.g., USA) enrollment in engineering and scientific professions is falling dramatically” (p. 262). The response by educators has been slow, even though the “vision of graduating engineers . . . will provide solutions to the world’s many problems as well as value service to society. . . . Various educators have . . . begun to think about incorporating sustainable development into university curriculum” (Hokanson et al., p. 255-256).

Based on evidence, “university students will learn differently when taught by different teachers and the reason for this is commonly assumed to be quite obvious: some teachers know more than others; either they know more subject knowledge and/or they
know more teaching skills” (Martin et al., 2000, p. 387). Some faculty approaches to teaching with technology are student-centered in that students are given more opportunities within the classroom to construct or develop their own understanding of the materials being covered. Other faculty approaches to teaching are teacher-centered, in that the teacher has all knowledge and knowledge is transmitted to students during lecture or seminar experiences (Ballantyne, Bain, & Packer, 1997; Hativa, 2000; Martin et al.; Saroyan & Snell, 1997; vanDriel, Verloop, van Werven, & Dekkers, 1997). Various instructional strategies tend to be considered a complex phenomenon throughout the teaching process because there is not a one-to-one relationship between the beliefs of teachers and the actual classroom practice of teachers. University faculty members develop instructional strategies based upon their beliefs, which are influenced by implicit and explicit theories and internal and external factors, such as cultural and contextual factors. These methods may or may not meet their students’ perceptions of how to learn the course material and may or may not meet the objectives for the course (Aguirre & Speer, 2000).

Technology may amplify inappropriate instruction when faculty adopt it for their courses by “focusing attention on the media and not the interaction of teaching, learning, thinking, and media . . .” (Rogers, 2001, ¶17). Faculty may believe in the benefits of technological innovations for the improvement of student retention and understanding, but the implementation of the innovation in their instruction may, in turn, be distracting students from learning course content. Innovations that are mainstreamed in classroom curriculum, including innovations with technology, provide an interesting opportunity to study faculty beliefs and practice. The dramatic increase in technology skills necessary to
keep up with technology savvy students may also impact how faculty believe and how they teach in their classroom.

To support and relieve some of the strain of an increased workload, faculty may implement instructional technology techniques in their classroom instruction, such as Chickering and Ehrmann’s (1996) “Seven Principles of Good Practice,” to help faculty members share useful resources, provide for joint problem solving, and promote shared learning. These instructional techniques and useful resources may augment face-to-face contact in and outside of class time. They may also be used to help support not only faculty members’ use of technology, but may also be essential to improve the progression of technology integration across the whole of the institution by including the advice and guidance from curriculum designers, policy makers, administrators, and students. It is becoming more important in this information age to understand if technology is enabling faculty to change the ways they learn and teach and to monitor if their higher education institution is taking advantage of the technologies to improve faculty teaching (Ehrmann, 1999).

A “conversational framework” was developed for academics that aimed to design appropriate methods for integrating learning technologies in university teaching (Laurillard, 2002). This framework “for describing the learning process is intended to be applicable to any academic learning situation: to full range of subject areas and types of topic. It is not normally applicable to learning through experience, nor to ‘everyday’ learning” (p. 87). To enable academics to design appropriate methods using technology, Laurillard discussed in detail what students need from learning technologies, such as
teaching as mediating learning, what students bring to learning, the complexity of coming to know, and generating a teaching strategy. Then, she focused on explaining the conversational framework for analyzing educational media, such as narrative media, interactive media, adaptive media, communicative media, and productive media (p. 87). Finally, she examined the design methodology, including designing teaching materials, setting up the learning context, and designing an effective organizational infrastructure. The conversational framework was identified as one way for academics to prepare for their teaching experiences, by guiding the development of effective teaching environments that integrate appropriate methods and tools.

Faculty members who have not received systematic preparation for their role as a teacher gain knowledge and beliefs about good teaching techniques and strategies by using self-evaluation and trial-and-error methods in their work and through reflection on student feedback (Hativa, Barak, & Simhi, 2001; Kane, Sandretto, & Heath, 2002). This nonsystematic and unplanned process “may lead to fragmented pedagogical knowledge and to unfounded beliefs about what makes teaching effective” (Hativa et al., p. 700). Kane et al. argued that “an understanding of university teaching is incomplete without a consideration of teachers’ beliefs about teaching and a systematic examination of the relationship between those beliefs and teachers’ practices” (p. 182). The research on teacher beliefs and practices focuses on improving student learning. How faculty teach is important to student learning, but it is not known how faculty beliefs impact their practices, especially in stressful situations such as innovating with technology in engineering courses in higher education. If it was understood how beliefs impact practice and how faculty members
innovate to change or improve their practice, then it may be possible to improve teaching, improve student learning, and improve support for faculty and students. In turn, faculty members would be more aware of their beliefs and their classroom practices using technology, which would help them evaluate their own instructional techniques and curriculum goals in order to improve their students’ understanding of the content material.

Problem Statement

Engineering faculty members are under pressure to improve their teaching by including a wide range of content and process skills. The engineering curriculum is very challenging; engineering practice comprises a variety of aspects. At the same time engineering faculty are not formally prepared to teach.

Engineering faculty are particularly knowledgeable about technology. Technology is being used to increase access to graduate studies in higher education, including engineering. Faculty members may teach through distance education environments to improve access to students, both on and off campus. However, the application of technology to learning and teaching is probably more reliant on pedagogical understanding than technical expertise (Palloff & Pratt, 1999). It is possible that teachers with a highly developed understanding of technology may be disadvantaged when adopting it for their teaching because of their strong beliefs in their ability to apply technology. These faculty members may assume that they know how to apply technology to teaching because of their general knowledge of technology.

The problem to be addressed in this study is that, although there is extensive research on the beliefs and practices of teachers in K-12 and in higher education, there is
relatively little focus on engineering education. These beliefs and objectives “may or may not be consistent with the behavior of the teacher [who] is observed during instructional interactions” (Aguirre & Speer, 2000, p. 333). Should engineering faculty show a similar disconnect between their espoused teaching beliefs and classroom practices using technology (as shown in the K-12 literature), then an in depth understanding of that disconnect is likely to inform practice in higher education, just as it has in the K-12 arena.

Objective for this Study

The objective for this research study was to examine and explore two engineering faculty members’ espoused beliefs, their observed instructional practice using technology, and their students’ perceptions of their classroom practices in a technologically equipped classroom that increases access to graduate studies in higher education.

Research Question

How do engineering faculty member’s espoused beliefs relate to his/her observed classroom practices using technology?

Context

The midwestern university where this research was conducted is a Carnegie Doctoral/Research-Extensive university accredited by the Higher Learning Commission, a commission of the North Central Association of Colleges and Schools. This university is particularly strong in the areas of science and technology. The participants selected for this research investigation were tenure track faculty members from the College of Engineering, which has a leading Engineering Distance Education (EDE) unit to support technology
infusion. Faculty members may choose to supplement their teaching by using EDE’s facilities and instructional technology support for their courses.

Methodology

The methodology begins with epistemology, because the study aims to provide a non-dualistic, phenomenographic perspective of engineering faculty (Chapter 3 describes these areas in more detail). The research study examined the relationship among engineering faculty members’ beliefs about teaching and their teaching practice using technology in higher education. In order to examine these relationships, the researcher used Shraw, Bendixen, and Dunkle’s (2002) Epistemological Beliefs Inventory, Martin et al.’s (2000) classifications for teachers’ objects of study and approaches to teaching, and Larreamendy-Joerns and Leinhardt’s (2006) three pedagogical views for online education. The theoretical backgrounds and frameworks will be described in further detail in Chapter 2 and Chapter 3.

Research Approach

This research study employed qualitative research methods. The qualitative approach for this phenomenographic study was single case study design because the phenomenon examined was intrinsically bound (limited) to two engineering faculty (Merriam, 1998). The study examined two faculty members’ beliefs and classroom practices using technology within their classroom context, a technologically equipped classroom, without any disruption of the natural surroundings. A pilot study was conducted to pretest the semi-structured interview questionnaire and observation schedules. This case
was a success and was deemed the first case study for this research investigation (see Chapter 4). Further details about the qualitative, case study research, including data methods and analysis, are explained in Chapter 3.

The planned sample for this study were tenure track faculty from the College of Engineering who volunteered to participate. There were approximately 200 tenure track faculty members employed within the College of Engineering at this university. Further descriptions of the sample used in this study are identified in Chapter 3

**Significance of the Study**

Primarily, this research investigation will provide in-depth descriptions of two engineering faculty members’ beliefs and classroom practices using technology. The in-depth descriptions will enable future researchers to generate studies that examine and strive to improve engineering faculty members’ awareness of their beliefs and reflection on their classroom practices using technology in order to increase the coherence between faculty members’ beliefs and practices.

This research investigation will also contribute to the knowledge base on beliefs and practices of engineering professors using technology. Consequently, the research informs participants about their teaching techniques and encourages them to become more reflective when applying technology in order to reach their core beliefs and curriculum goals.

Teacher beliefs and teacher practice research has focused mainly on assessing instruction to improve student learning. Promoting faculty awareness of their beliefs and their practice is important in higher education to ensure that faculty instruction is coherent
and that faculty members constantly reflect on their own teaching in order to continuously improve student learning of the content material. Results from this study highlight the importance of beliefs and practice for engineering faculty members. In addition, specific engineering faculty may have the opportunity to improve their teaching practice by having participated in this research study. EDE units may be able to improve their support and use of technology according to the findings from this research study. In addition, by understanding knowledge about higher education teaching processes, the university’s policies and procedures may be informed by this study.

Summary

In order to understand if engineering faculty members employ strategies that effectively communicate course content to students in a way that is meaningful, I examined the relationship among two engineering faculty member’s beliefs and their observed classroom practices in a technologically equipped classroom. Further details of the methods are explained in Chapter 3. Participants’ beliefs were analyzed using Martin et al.’s (2000) classification for teachers’ objects of study and approaches to teaching. Further details of the theoretical background and frameworks are described in Chapter 2.

Structure of the Dissertation

Chapter 1. Introduction

The introduction provided an overview of the dissertation. The chapter began by introducing the engineering context and the need for understanding the phenomena of engineering faculty members’ beliefs and practices. Then, the objectives and research
questions were identified in order to establish the direction of the research investigation, which was to examine the relationship among engineering faculty members’ espoused beliefs and their classroom practices using technology. Next, the methods and approaches were outlined to describe the data collection and methods used in this research investigation, such as case study methodology. Finally, a discussion of the significance of the study outlined the importance of the research study.

Chapter 2. Literature Review

The literature review provides a review of the relevant literature in the field of faculty beliefs and practices. The chapter begins by analyzing and presenting literature about ways that faculty members prepare to teach in university settings and lays out descriptions and definitions of the terms teacher beliefs, teacher knowledge, and teacher practice. Then, the literature on faculty pressures and roles are synthesized in order to identify the complexities of academic work, including technology integration. As a result, the researcher analyzes the literature on faculty adoption of technology to address technology integration in higher education institutions.

Next, the literature on strategies for planned change is reviewed in order to identify the strategies applied in higher education to integrate technology, including the types of resistance exhibited by faculty. Finally, the literature review returns to research on teacher beliefs and practices in order to compare and contrast research studies conducted to examine the relationship among the two perspectives.
Chapter 3. Methodology

The methodology presents the research methods and approaches for the research study. The chapter begins by describing the participant researcher and the EDE context, which is the context for the case studies. Next, the methods of the first case study are described, including the aim, data collection methods, participants, and the semi-structured interview protocol design. Then, the researcher explains the items that were changed before conducting the second case study, such as the adding of the technology-specific questions to the interview protocol. Next, the methods of the second case study are described, including the aim, data collection methods, participants, and the semi-structured interview questionnaire. Subsequently, the methods for analyzing the case study data is described, including the five stages of analysis. Finally, the ethical considerations are explained for the research investigation.

Chapter 4. Findings from the First Case Study

This chapter provides a case study of one engineering faculty member’s espoused beliefs and classroom practices using technology. The findings begin by introducing the background of Dr.K (pseudonym), the faculty member for the first case study, followed by his espoused beliefs. The descriptions of Dr. K’s teaching, including the use of technology are then presented, followed by his course description. The analysis of this first case study then contrasts Dr. K’s beliefs with his teaching. The phenomenon of Dr. K’s espoused beliefs and classroom practices using technology is then presented, followed by an exemplary vignette of Dr. K’s teaching that is compared with the findings from Martin et
Chapter 5. Findings from the Second Case Study

This chapter provides a case study of one engineering faculty member’s espoused beliefs and classroom practices using technology. The findings begin by introducing Dr. J (pseudonym), the faculty member, followed by a description of Dr. J’s course, the context. Following the description of his course, Dr. J’s espoused beliefs are presented. The findings from Dr. J’s teaching, including the use of technology are the described, followed by an analysis that compares and contrasts Dr. J’s espoused beliefs with his teaching. The phenomenon of Dr. J’s espoused beliefs and classroom practices using technology was then presented, followed by an exemplary vignette of Dr. J’s teaching compared with the findings from Martin et al. (2000). The findings end with a summary of this case study. The chapter concludes with proposed improvements for future research studies.

Chapter 6. Discussion, Implications, and Recommendations

The concluding chapter starts with a summary of the findings concerning the two faculty members’ espoused beliefs and observed classroom practices, before connecting these to faculty members’ preparation for instruction. The second part of the chapter summarizes findings relating to technology, starting with the faculty members’ beliefs and practices using technology, followed by the findings pertinent to the members of staff in the EDE unit that supported faculty use of technology in their instruction. The chapter ends
with a summary of recommendations that emerged from this original research study for improving practice and future research.
CHAPTER II
LITERATURE REVIEW

Introduction

This chapter presents a review of literature that underpins this research investigation. The first section, Faculty Preparation, analyzes and presents literature about ways that faculty members prepare to teach in university settings and describes and defines the terms teacher beliefs, teacher knowledge, and teacher practice. The second section, Faculty Pressures and Roles, synthesizes literature related to the complexities of academic work. The third section, Faculty Adoption of Technology, addresses technology integration in higher education institutions.

Section four, Strategies for Planned Change, reviews strategies applied in higher education to integrate technology and the types of resistance exhibited by faculty, illustrated with accounts from projects that investigated such innovations. The final section, Teacher Beliefs and Practices, returns to research on teacher beliefs and teacher practices in order to compare and contrast research studies conducted to examine the relationship between these two perspectives. The chapter concludes with a summary of important findings from the literature reviewed.

Methodology

The methods for this literature review included gathering, selecting, and analyzing papers and other sources related to the research question identified in Chapter 1: “How do an engineering faculty member’s espoused beliefs relate to his/her observed classroom
practices using technology?” Key terms were identified including: professional development, teacher preparation, faculty development, espoused beliefs, classroom practices, technology, information technology, instructional technology, and ICT. These were entered in search engines including ERIC, the ISU library catalog, Google scholar, and Ingentaconnect. Online journals were also used to search for relevant articles (e.g., Instructional Science and the American Society for Engineering Education [ASEE]). The abstracts were scanned and those that did not fit the question were discarded. The remaining literature was read in full and notes made on the article and key terms were entered against each item in a spreadsheet (110 items). The references were also scanned for additional literature, and this was added to the collection. This research appeared to be exhaustive, because there were repeated hits on articles in the collection.

Experts in engineering education were also consulted for sources. Key terms and findings were used as categories for a variety of sorted lists to aid analysis. Finally, the literature was drafted into several categories, and following further analysis, the sections in this literature review emerged. A number of studies were located in Australian and other international literature. As a scholar, I recognize the inherent dangers when drawing on studies produced in different contexts and in different countries, and I have exercised caution when making comparisons and linking various studies (Bullough, 1997).

Faculty Preparation

A review of the literature on university faculty implies that university faculty members receive little preparation to teach in university classrooms. “Academics are expected to be well qualified in their discipline area, but knowledge of educational theories,
or even expertise in teaching, are not normally required for appointment” (Kember, Kwan, & Ledesma, 2001, p. 393). “Lecturers in higher education are usually expected to be good teachers and good researchers, but typically receive little teacher training” (Roche & Marsh, 2000, p. 446). There was also a lack of literature that explained or described engineering faculty members’ preparation programs. This lack of information implies that engineering faculty members do not have a formal faculty preparation program in place for their future engineering faculty members.

From this lack of literature it was assumed that faculty members’ preparation to teach in classrooms relied almost exclusively upon becoming a teaching assistant during graduate school, whereas in K-12 teacher education programs, “initial training has traditionally involved students studying the practice of teaching, reinforced through teaching placements and the study of formal source discipline, primarily sociology, philosophy, and psychology” (Hillier, 1998, p. 35): K-12 literature was included in this review to provide deep understandings of the teaching processes (Kane et al., 2002; Kember, 1997).

Education students learn about human development, specific teaching approaches (i.e., from didactic to constructivist approaches) and how they “fit” within classrooms, student learning, and action research (i.e., teachers actively research their own teaching in order to improve how they are teaching their students). These students’ “prior experience and [learned] beliefs are central to shaping the storyline, as is the context of becoming a teacher” (Bullough, 1997, p. 95). The “beginning teachers cope with the dilemmas of
student teaching in ways that maintain their beliefs, their conceptions of themselves as teachers, while looking ahead to having their own, ‘real’ classroom” (p. 83).

Student teachers are challenged with classroom problems, control, and building productive relationship with the students that “often force a confrontation with the novices’ conceptions of teaching” (p. 87). The “teacher education courses and programs that challenge participants’ pre-existing beliefs can be successful in helping them develop knowledge and beliefs more consonant with those advocated by teacher educators” (Putnam & Borko, 1997, p. 1296). Although, engineering teaching assistants may be confronted with similar situations, without formal education they may be unaware of how to improve or change their approaches or methods within their classroom. Similarly, practitioners who are unable to participate in staff training and development “may be less likely to be influenced by theory” (Hillier, 1998, p. 36). They may be unclear about “general pedagogical knowledge [which] includes a teacher’s knowledge and beliefs about teaching, learning, and learners not specific to particular subject-matter domains” (Putnam & Borko, p. 1229).

As a result, their beliefs, knowledge, and practices exhibited in the classroom may vary making it difficult for their students to fully grasp or clearly understand the course content a meaningful way. In order to understand the similarities and differences in different teaching practices it may be useful to recognize, at this point, the terms used throughout this research investigation relating to the teaching process. The terms outlined below are: teacher beliefs, teacher knowledge, and teacher practice.
Teacher Beliefs

Research conducted in the early 1980s focused on detecting teaching behaviors that resulted in higher student achievement and training teachers to exhibit desirable behaviors, either in teacher education programs or by means of additional professional development (Verloop, VanDriel, & Meijer, 2001, p. 441-442). Recently, research on teaching has “changed from studying teacher behavior [to] studying teacher cognitions and beliefs underlying that behavior, based on ideas about the interaction between them” (Verloop et al., p. 442). Teacher beliefs are formed by past experiences, implicit and explicit theories, and a variety of principles, all of which are organized to influence the selection and prioritization of objectives that then influence the actions of teachers in classrooms (Aguirre & Speer, 2000). This causes a dilemma, in that, teachers may apply their beliefs within the classroom based on their perceptions of how their students learn the course material (Aguirre & Speer) and they may base their teaching on “restricted definitions such as ‘behavioral prescriptions on effectiveness studies’” (Verloop et al., p. 442).

Faculty base their objectives for their courses on their own beliefs of the course, their teaching, and their discipline (Quinlan, 1999). They also share elements of their knowledge with other teachers “or large groups of teachers . . . who teach pupils of a certain age level” (Verloop et al., 2001, p. 443). Schraw (2001) identified studies in “the hard sciences, such as physics and engineering, [that] reported more sophisticated beliefs than those in education and the humanities” (p. 458). This review indicated that a faculty member’s personal beliefs and their colleagues’ espoused beliefs may have an influence on
each individual faculty members’ classroom practices, which may enhance the refinement of their beliefs.

Although faculty members’ beliefs may influence their practice, there are some beliefs that influence faculty more than other beliefs. In order to help organize all of these beliefs, Green (1971) developed a structure that hierarchically organized beliefs based on how the person holds her or his beliefs. Some of the beliefs were fundamental to the person’s belief system, which gave those beliefs top position in the structure, and other beliefs were derived from or related to the fundamental beliefs, which gave them a lower level in the hierarchy dependent upon relative closeness to the fundamental belief. In understanding the level to which faculty members’ beliefs are identified, support personnel and administrators may be able to fit new innovations with the individualized needs and beliefs of faculty members.

In contrast with Green’s (1971) hierarchical belief structures, one review (Aguirre & Speer, 2000) addressed how people explained their beliefs (“professed” beliefs) and observed others’ beliefs (“attributed” beliefs). These factors were identified as having an impact on their classroom practice. Teachers explained their “professed” beliefs and objectives through academic discourse and discussions, even though these beliefs and objectives “may or may not be consistent with the behavior of the teacher that is observed during instructional interactions” (Aguirre & Speer, p. 333). “Since we are talking about mental constructs, these attributed beliefs and [objectives] are not necessarily the exact ones that teachers hold or would articulate, but they are the constructs that are consistent with and enable us to explain the teacher’s actions” (Aguirre & Speer, p. 333).
When it is stated that the teacher has this belief or this objective, then it can be inferred that the teacher is behaving in a certain manner that is consistent with having such a belief or objective. Some of the beliefs and objectives may be short term and immediate, and others may be long term or broad in scope, such as beliefs “deeply rooted in specific cultural antecedents and social structures” (Pratt, Kelly, & Wong, 1999, p. 241).

Additionally, beliefs can be pre-existing or they could emerge throughout classroom interactions (Aguirre & Speer, 2000).

Teachers should be aware of their students’ opinions when examining their own teaching beliefs, because it is the students who are to understand the content being disseminated from the teachers (Reid & Johnston, 1999). Students from Reid and Johnston’s study indicated that they needed “a more student-participative approach to teaching and learning” (p. 280). This approach “demands an environment of support outside as well as inside the classroom” (p. 280). “Attributed” beliefs and objectives are those consistent with the teacher’s practice and may be identified by a researcher/observer (Aguire & Speer, 2000). These beliefs and objectives may or may not be consistent with what teachers profess to others.

The research on epistemic beliefs addresses “individual’s beliefs about the nature of truth and knowledge. . . . In the early stages, individuals hold simple, dichotomous views of knowledge; reasoning then becomes increasingly more complex and relativistic” (Bendixen, 2002, p. 191). The study of epistemological beliefs is important because “it is an attempt to understand the learner’s perspective” (Schommer-Aikins, 2002, p. 108). “It seems plausible that teachers’ epistemological beliefs influence instruction and assessment.
Instruction and assessment, in turn, are likely to influence students’ developing epistemological beliefs” (Schommer-Aikins, 2004, p. 27). If instructors deepen their understanding of the process then they are more likely to enhance teaching effectiveness (Hofer, 2002, p. 13).

In this research investigation the focus is on the faculty members’ espoused beliefs and their classroom instruction using technology. From an applied point of view, it may not seem necessary to understand the faculty member’s perspective as long as the faculty member is learning and teaching. When the faculty members’ thinking goes awry it may cause a possible disconnect between their espoused beliefs and classroom instruction using technology. In such a case, an in-depth understanding of faculty members’ beliefs and practices may identify possible sources of this phenomenon and identify ways to better align faculty members’ beliefs with their classroom instruction using technology.

A theoretical framework (on epistemic beliefs) was originally developed by Schommer in 1990 to “test the personal epistemology as a system of more or less independent beliefs. By system of beliefs it is meant that there is more than one belief to consider in personal epistemology” (Schommer-Aikins, 2002, p. 104, also mentioned in Schommer, 1990, p. 498). The framework was discussed in Schommer-Aikins (2002) and described the “epistemological belief system based on accumulating evidence and reflection” (p. 106). “With the introduction of an epistemological belief system, these beliefs were conceptualized as unique entities . . . to tease apart aspects of previous thick descriptions and allow more analytical inspection of individuals’ epistemological beliefs”
(Shommer-Aikins, 2004, p. 21). A brief summary of the theoretical framework identified that (Shommer-Aikins, 2002):

1. Personal epistemology may be conceptualized as a system of beliefs; that is personal epistemology is composed of more than one belief.

2. Beliefs within the system are more or less independent; that is, it cannot be assumed that beliefs will be maturing in synchrony. First, it is important to understand that among many epistemological belief researchers, epistemological maturity was presumed to be indicated by the learner’s propensity to believe that knowledge is tentative and complex and that learning is gradual and controllable. To be in synchrony would mean that learners believe all four of these attributes. As an example of asynchrony, at some point in time an individual may strongly believe in complex knowledge (considered a more mature belief) and simultaneously strongly believe in unchanging knowledge (considered a less mature belief). My point of more or less independent is that learners may, or may not, be in synchrony. It simply cannot be assumed one way or the other; rather, in practice development should be determined on a case-by-case basis.

3. Epistemological beliefs are better characterized as frequency distributions rather than dichotomies or continuums. For example, it is likely that a mature learner believes that a small percentage of knowledge is unchanging and a substantial percentage of knowledge is evolving.

4. Epistemological beliefs have both indirect and direct effects. By indirect effect it is meant that epistemological beliefs mediate learning. . . As an example of a
more direct effect, strong belief in certain knowledge may serve as a filter in interpreting tentative text as if it were definitive.

5. Whether epistemological beliefs are domain general or domain independent will vary over time (for any particular individual).

6. Epistemological belief development and change is influenced by experience. These experiences include engaging in problem solving and learning from family, friends, formal education, and life experiences. (p. 106-107)

The more mature learner has a small share of the frequency distribution for isolated, unchangeable beliefs, and the less mature learner has a large share of the frequency distribution for isolated, unchangeable beliefs (Schommer-Aikins, 2002). “The rationale used in designating epistemological sophistication is that the beliefs support quality study strategies, quality comprehension, quality interpretation, and quality problem solving” (Schommer-Aikins, 2002, p. 113). The difference identified between sophisticated epistemological beliefs and less sophisticated beliefs is that “the sophisticated learner will maintain epistemological beliefs that support flexible thinking, yet underlying that ability to take in new ideas or change old ideas, will be a steadfastness of course concepts” (Shommer-Aikins, 2002, p. 113, also mentioned in Schommer-Aikins, 2004, p. 21).

“Maturity and life experience, particularly educational experience, are often mentioned as the most likely contributors to the development of epistemological understanding” (Kuhn & Weinstock, 2002, p. 138).

Personal epistemology is “a field that examines what individuals believe about how knowing occurs, what counts as knowledge and where it resides, and how knowledge is
constructed and evaluated” (Hofer, 2004, p. 1). It is “engaged as we engage in learning and knowing . . . and will in some way determine what and how we make meaning of the information we encounter” (Hofer, 2002, p. 3). There are many difficult aspects that arise when studying personal epistemology. “One of the most difficult aspects of the study of personal epistemology has been how to capture something as elusive as individual conceptions of knowledge and knowing” (Hofer, 2002, p. 9). “Epistemological beliefs will vary in multiplicity, generality, and independence over time. This variation adds to the challenge of attempting to define and measure epistemological beliefs” (Schommer-Aikins, 2002, p. 109).

To study the complexity of the beliefs about the nature of knowledge, Schommer (1990) first proposed to examine five dimensions of beliefs, which were “the structure, certainty, and source of knowledge, and the control and speed of knowledge acquisition” (p. 498). These dimensions were used in an epistemological questionnaire (Schommer, 1990) used to empirically examine personal epistemologies of individuals. The questionnaire addressed the range of the dimensions as:

(a) Knowledge is simple rather than complex (Simple Knowledge), (b) Knowledge is handed down by authority rather than derived from reason (Omniscient Authority), (c) Knowledge is certain rather than tentative (Certain Knowledge), (d) The ability to learn is innate rather than acquired (Innate Ability), and (e) Learning is quick or not at all (Quick Learning). (p. 499)

The study found that:
(a) Personal epistemology can be characterized as a system of more or less independent beliefs; (b) these beliefs have distinct effects on comprehension and learning; (c) epistemological beliefs are influenced by home and educational background; (d) these effects exist beyond the influence of variable found to influence comprehension and learning; and (e) these effects are generalizable across two domains [nutrition and psychology]. (Schommer, 1990, p. 503)

The research on individuals’ epistemological beliefs “was an effort to use converging measures in order to understand a complex phenomenon . . . epistemological beliefs do not function in a vacuum” (Schommer-Aikins, 2004, p. 22). After the development and examination of this questionnaire (Schommer, 1990) many other researchers began to develop new questionnaires (Schraw et al., 2002; Wood & Kardash, 2002). Schraw et al. “modified the questionnaire and proposed slightly different sets of five epistemological beliefs” (i.e., changing innate ability to fixed ability; Schommer-Aikins, 2004, p. 22). Schraw et al.’s Epistemological Beliefs Inventory (EBI; described further in Chapter 3) and Schommer’s (1990) five dimensions (described above) were used to analyze and describe the findings in this research investigation.

The definition of teacher beliefs that will be used for the purposes of this research investigation is: teacher’s past experiences, implicit and explicit theories, and a variety of principles that are organized to influence the selection and prioritization of objectives that then influence the actions of teachers in classrooms (Aguirre & Speer, 2000).
Teacher Knowledge

Teacher knowledge is formed by teachers’ beliefs, their own past experiences, and by making implicit theories explicit (Kane et al., 2002). Nevertheless, these phenomena may be so complex that teachers have a hard time articulating them, which also means that they may have a hard time making teacher knowledge available or accessible to them (Verloop et al., 2001). “Novice and experienced teachers alike often lack the subject-matter knowledge that is needed in order to be responsive to students’ thinking in ways that foster learning with understanding” (Putnam & Borko, 1997, p. 1232). So, how are teachers supposed to examine their own knowledge in order to improve their teaching and their students’ learning if they are unable to articulate them and make them available to themselves?

A review of the literature examined reflection processes as a way of building teacher knowledge (McAlpine & Weston, 2000). The authors indicated that the “ongoing use of the process of reflection [including monitoring and decision-making] is essential for building knowledge, and increasing knowledge increases one’s ability to use reflection effectively and to develop as a teacher” (p. 364). They also found that reflection occurs asynchronously: “prior to, concurrent with, and retrospective to instruction” (p. 364), which enables teachers to analyze their teaching constantly. In integrating reflection processes into teaching, teachers may be enabled to evaluate their teaching and make decision as they progress through simple and/or complex course materials.

All of these complexities involving teacher knowledge are otherwise known as the tacit dimension, and within this dimension knowledge is identified as tacit knowledge.
(Polanyi, 1966). It was expressed in the work of Schommer-Aikins (2002) that “part of the challenge of assessing epistemological beliefs was dealing with the idea that epistemological beliefs are for the most part unconscious, if not tacit” (p. 115). Tacit knowledge helps people prepare for objectivity in our living world. Polanyi identified that tacit knowledge “is shown to account (1) for a valid knowledge of a problem, (2) for the scientist's capacity to pursue it, guided by his sense of approaching its solution, and (3) for a valid anticipation of the yet indeterminate implications of the discovery arrived at in the end” (p. 24). In the classroom, for example, tacit knowledge dwells in the awareness of experiences while influencing individuals with whom the experiences jointly comprise. In order to distribute this understanding, the student must focus on the same kind of understanding that the teacher is exhibiting in order to understand the materials. In doing so, the students would be accepting the teacher’s influence (Polanyi, 1966) for understanding the subject matter, instead of having students use their own experiences to form their own meaning of the teacher’s experiences.

Knowledge in higher engineering education was researched by vanDriel et al. (1997). They did not call the knowledge tacit knowledge; instead they called the knowledge “craft knowledge” or “practical knowledge.” Craft knowledge was described as “the knowledge and beliefs teachers have with respect to their teaching practice, and is mainly derived from teaching experience” (vanDriel et al., p. 106) and “a specific component of knowledge that is mainly the product of the teacher’s practical experience (Verloop et al., 2001, p. 446). They suggested that research into craft knowledge has been relatively scarce.
in higher engineering education, even though, research into craft knowledge may help contribute to the empowerment of teachers in their work (vanDriel et al.).

The definition of teacher knowledge that will be used for the purposes of this research investigation is: teachers’ past experiences, values, and their ability to make implicit theories explicit (Kane et al., 2002) with respect to their teaching practice and their practical experiences (VanDriel et al., 1997; Verloop et al., 2001).

Teacher Practice

The objectives, methods, theories, ideologies, and beliefs that teachers utilize in their classrooms that guide their practices, varies from teacher to teacher (van Manen, 1999). Teacher practice should be teachable and tangible: “This is important for teacher development. Only if a practice of teaching is itself teachable, imitable, or somehow conveyable can we meaningfully talk of teacher education or professional development of teachers” (van Manen, p. 2). The term “practice” invites teachers to “be observant of the ordinary phenomena in the lifeworlds of schools, concerns that have been largely overlooked and that tend to be marginalized in educational research” (van Manen, p. 3).

The definition of teacher practice that will be used for the purposes of this research investigation is: teachers’ past experiences, values, and their ability to make implicit theories explicit (Kane et al., 2002) by carrying out in action innovations that are imitable, teachable, or conveyable (van Manen, 1999).
Faculty Pressures and Roles

Faculty members are confronted with a variety of internal and external pressures that may or may not have much bearing on their instructional quality and their roles as a faculty member (Serow, 2000). For instance, faculty members “bring social norms concerning appropriate roles, responsibly, and relationships for teachers” (Pratt et al., 1999, p. 251). Freire (1998) also affirmed that the teacher’s task, not only as a learner, is both rigorous and joyful, demands seriousness and scientific, physical, emotional, and affective preparation, and requires that those who commit themselves to teaching develop a certain love not only of others but also of the very process implied in teaching. In addition, recent studies on faculty behavior view teaching as a process of improving the knowledge (lifelong learning skills) and quality (i.e., prepared to be responsible citizens) of the future members of today’s society through resource dependency and economic globalization (Putnam & Borko, 1997; Serow). It was also identified that “higher education institutions have worked hard to encourage lifelong learning, support tax credits for education, provide non-credit courses for workers, deliver courses through a variety of distance media, and provide flexible scheduling” (Rogers, 2001, ¶8).

Faculty members also engage in other academic roles in universities. Kreber (2000) identified that in American higher education literature “academic work consists of research teaching and service, where teaching is sometimes divided into instruction and advising, and serve into various forms of instructional governance and community work” (p. 62). Serow (2000) found that faculty in research extensive universities tend to focus more attention on research than on teaching. Therefore, “the status of undergraduate instruction
at research universities is . . . something of an anomaly. Preferred by many faculty
members and insisted upon by key external constituencies, teaching nonetheless carries
little weight in the academic reward system of these institutions” (Serow, p. 451). “Most of
the training and much of the positive reinforcement that academics receive bears on
research demands” (Roche & Marsh, 2000, p. 456). The conflicting roles of teaching and
research have “historically been resolved in favor of research” (Banta, 1966, p. 437). This
does not imply that advising and teaching were ignored altogether, but were not seen as
important as scholarly research (Serow).

Faculty instruction may be based only on their own beliefs and their own past
experiences (Newton, Newton, & Oberski, 1998; Pratt et al., 1999; Putnam & Borko, 1997)
not on the experiences of their students or their colleagues. One review found that “the
process of becoming a better teacher usually refers to modifying classroom teaching
behaviors and replacing ineffective teaching strategies and techniques with more effective
ones” (Hatva, 2000, p. 491). Faculty members are likely to espouse understanding of
pedagogy, but fall short of putting it into practice. Instruction in the classroom is a “process
of substituting scientific data from preconceived and half-formed notions” (Bowden, 1931,
p. 634), which may look behaviorally the same on the outside, but each individual teacher
acquires and develops their teaching practices in a personal manner that may be entirely
different in situational and biographical settings (van Manen, 1999). As a result of these
differences, U.S. universities “are currently under some pressure to improve undergraduate
instruction” (Serow, 2000, p. 450). Given this information, it is recommended that future
and current faculty members be informed and educated with effective and appropriate
teaching approaches and methods, which may or may not include the adoption of technologies.

Faculty Adoption of Technology

Many faculty members have implemented innovations (e.g., new teaching approaches, technology, alternative methods, etc.) to keep up with an ever-changing society, with the hopes that all of their students will become successful citizens (vanDriel et al., 1997). Faculty members have also implemented instructional technology into their classrooms to effectively communicate material to students using innovations with technology. A review of the literature identified the need for teachers to encourage and support students in the use of sophisticated technologies (i.e., Internet, CD-ROM, etc.) to promote the distribution of cognition among people and cognitive tools in the classroom (Putnam & Borko, 1997, p. 1275). To meet these needs, “advanced technological development must occur in our schools and educational institutions if we are to prepare students for a competitive global marketplace” (Dooley, 1999, p. 1). Technologies have the “potential not only to enrich existing classrooms but, equally important, to allow institutions to reach out to new target groups, such as lifelong learners, people in the workforce, and the physically disabled” (Bates, 2000, p. 28).

In a review of the literature it was identified that “there are many interrelated reasons for this pressure on higher education institutions to change” (Bates, 2000, p. 8). Three are of particular significance to the current study:

- The changing learning needs of society
- The need to do more with less
The impact of new technologies on teaching and learning. (Bates, 2000)

Faculty members are now recognizing that these three reasons are “unlikely to go away . . . unless significant changes are made” (Bates, 2000, p. 9). A lack of institutional change may lead to far too many disturbing practices that appear to be sustained indefinitely (Miles, 2000, p. 757).

As a result, technology innovations have been implemented in higher education institutions, although only a select few of these technology innovations have been adopted by every stakeholder (e.g., faculty members, tenure track faculty members, teaching assistants, lecturers, teachers, adjunct professors, etc.). This could be due to “unintended consequences of technology and resistance to change among faculty, staff, and students” (Surry, Ensminger, & Haab, 2003, p. 2). For example, research on K-12 classroom teachers found “that teachers use technology in a way they think is aligned with their beliefs, but on close inspection the teachers’ lessons are misaligned or [incongruent] with the teachers’ convictions” (Judson, 2006, p. 582). “The vast majority of educational innovations did not materialize at all or failed after some time because the teachers, after a period of change, abandoned the new behavior and returned to the old routines with which they were comfortable” (Verloop et al., 2001, p. 453). To supplement as well as direct the implementation of technology innovations, varying innovation models and instructional strategies have been implemented into many higher education programs as means to provide stakeholders with strategies for implementing their chosen technology innovations within and outside of their classrooms. Further, certain approaches to computer use and a schoolwide emphasis of technology may be great forces to allow teachers to realize the
importance of technology and the pedagogical changes that are more attuned to technology integration.

Teachers may also be more aware of how to integrate technology into their course content for their students to better understand the materials with the support of technologies. A review of the literature on current expectations of students in higher education stated that:

As learners began to take advantage of technology in learning in the early 1990’s, they came to expect distance learning to be high-quality (include current content), convenient (available, accessible, and flexible in scheduling), individualized (the instruction matches learning styles and individual schedules), and interactive (providing active learning experiences supported by personal contact with the instructor and other students through synchronous or asynchronous means).

(Rogers, 2001, ¶14)

Students are asking for specific “characteristics to be present in the learning environment in order for them to experience learning as convenient, affordable, and significant cognitive change” (Rogers, ¶15).

Guidance for faculty development of instructional practices and innovations with technology has been implemented into higher education institutions to help faculty integrate new technologies effectively into their teaching using effective instructional practices (Chickering & Ehrmann, 1996). The Seven Principles of Good Practice are: (1) Good Practice Encourages Contacts Between Students and Faculty, (2) Good Practice Develops Reciprocity and Cooperation Among Students, (3) Good Practice Uses Active

Any instructional strategy above can be supported by various technologies, but for any given strategy some technologies are better than others. In addition, faculty members may develop solutions to problems in their classrooms that rely on technology alone. This often leads to solutions that are unsustainable (Grose, 2004).

According to Chickering & Ehrmann (1996), the Seven Principles of Good Practice may or may not be implemented by faculty alone and may become familiar to the students in the classrooms, because the students should be empowered to become more assertive with respect to their own learning. If students are faced with instructional strategies and course requirements that use technology in ways opposing the Seven Principles, then students should try out various strategies, acquire additional resources, glean complementary experiences, establish study groups, and/or ask the instructor for substantial feedback and activities that help to serve them better (Chickering & Ehrmann).

The widely cited book, *Rethinking University Teaching*, focused on implementing innovations into instructional practices for academics (Laurillard, 2002), as did the Seven Principles of Good Practice (Chickering & Ehrmann, 1996), and on how academics need to think about teaching, not just how they teach their subject. Laurillard (2002) states that academics:

…need to know more than just their subject. They need to know the ways it can come to be understood, they ways it can be misunderstood, what counts as
understanding: they need to know how individuals experience the subject. However, they are neither required nor enabled to know these things. Moreover, our system of mass lecture, examinations, and low staff:student ratios ensures that they will never find them out. (Laurillard, p. 3)

Academics “need to rebuild the [organizational] infrastructure that will enable a fit between the academic values we wish to preserve and the new conditions of educating large numbers” (Laurillard, p. 4). Those who pursue Laurillard’s guidance may “find an infrastructure that enables [them] to be as professional in their teaching as they aspire to be in their researcher” (p. 4). This may enable faculty members, support personnel, and administrators to rethink the organizational infrastructure in which academics teach in order to continually improve the quality of their students learning. This model was developed in the first distance education university, The Open University in the United Kingdom, so caution is required in its application.

A recent literature review of online education found three predominant pedagogical views in online instruction that implied assumptions about the goals of teaching, which were: what it means to know; the mechanisms, tools, and mediations that leverage learning; and the anticipated scenarios for knowledge use (Larreamendy-Joerns & Leinhardt, 2006, p. 584). These three pedagogical views (Larreamendy-Joerns & Leinhardt, 2006) are:

1. The presentational view “sees the unique potential of online education in the increase visualization and presentational capabilities of online multimedia environments, which overcome the limitations of text and static representations”
Classroom presentations would be rich in representational formats and embodied in distinct ways (p. 585).

2. The performance-tutoring view “sees the potential of online education in environments that support problem-solving and that allow for precise instructional guidance through highly structured tasks and timely feedback” (p. 584). “Computers recreate complex problem-solving tasks, emulating and supporting critical features of pedagogical exchanges between students and teachers” (p. 586).

3. The epistemic-engagement view “sees the potential for online education in environments that foster the epistemic and discursive practices typical of disciplinary communities by providing a wide range of opportunities for intellectual engagement and interaction” (p. 584-585). Students are given “opportunities for participatory practice and, as competencies develop; they seek and obtain supporting skills and concepts” (p. 590).

These three pedagogical views may be very useful to inform distance education. They may also be used to improve support from staff members and possibly encourage further development towards a more epistemic-engagement view of online instruction (Larreamendy-Joerns & Leinhardt). This review is discussed further in Chapter 6.

Strategies for Planned Change

Individuals implementing innovations may become uncertain or uneasy when trying to learn and teach with a new medium or instructional strategy, which could adversely affect the rate of adoption by an individual or an organization (Sherry, Lawyer-Brook,
Black, 1997). “Uncertainty implies a lack of predictability, of structure, of information. In fact, information is a means of reducing uncertainty” (Rogers, 1995, p. 6). It would make sense, in the least, to examine the concerned teachers that were to implement an innovation first in order to understand their teaching practices before implementing a major innovation or change (Verloop et al., 2001). In doing so, the concerned teacher may be supported in aligning the innovation with their specific teaching practices to support student learning of the course material (Verloop et al.).

A theoretical framework based on research evidence described the adoption and diffusion of innovations throughout social systems and organizations (Rogers, 2003). The major elements “in the diffusion of new ideas are: (1) an innovation (2) that is communication through certain channels (3) over time (4) among the members of society” (p. 36). The theory of diffusion of innovations defines an innovation as a practice, idea, or object that is perceived as new by an individual (Rogers, 2003, p. 12). “The characteristics of innovations, as perceived by individuals, help to explain their different rates of adoption” (Rogers, 2003, p 15). For example, if an innovation is difficult for intended adopters, then they may not choose to implement the innovation into their learning or teaching. On the other hand, if the innovation is perceived by the intended adopter to make work easier, then they may learn more about the innovation in order to implement it into their learning and teaching.

The five variables identified in the review of the literature that determined the rate of adoption of innovations were: perceived attributes of the innovations, the type of innovation-decision, communication channels, nature of the social system, and the extent
of change agents’ promotion efforts (Rogers, 1995, p. 222). However, these variables “have not received equal attention from diffusion scholars. The five perceived attributes of innovations have been most extensively investigated and have been found to explain about half of the variance [“49 to 87 percent” (p. 221)] in innovations rates of adoption” (p. 222). The five perceived attributes of innovations are (as defined by Rogers, 2003, p. 15-16):

1. Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes.

2. Observability is the degree to which the results of an innovation are visible or not visible to others.

3. Compatibility is the degree to which an innovation is perceived as being consistent with the past experiences, existing values, and needs of the potential adopters.

4. Complexity is the degree to which an innovation is perceived as difficult to understand, use, and maintain.

5. Trialability is the degree to which an innovation may be experimented with on a limited basis.

These are perceived by members of the social system in the process of adopting innovations and determine its rate of adoption (Sherry, 1997, p. 2). “Past research indicates that these five qualities are the most important characteristics of innovations in explaining the rate of adoption” (Rogers, 2003, p. 16-17).

The innovation-decision making process “is the process through which [an individual] passes from first knowledge of an innovation to forming an attitude toward the
innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision” (Rogers, 2003, p. 37). The process ranges from knowledge about an innovation to confirmation by adoption.

Five adopter categories of member innovativeness in the *Diffusion of Innovations* were addressed as “ideal types, concepts based on observations of reality that are designed to make comparisons possible” (Rogers, 2003, p. 282). These categories were: innovators, early adopters, early majority, late majority, and laggards. The innovators were identified as the first individuals to try out and implement innovations into their learning and teaching, whereas laggards were identified as the “last in a social system to adopt an innovation” (p. 284) in their learning and teaching.

The innovation this research investigation focused on was instructional technology. In adopting the innovation, faculty members rely on their colleagues, administration, or various forms of information gathering in order to teach them techniques and strategies for their personal use and use within their classrooms. By using instructional tools and techniques in their teaching, faculty members demonstrate that they have adopted the innovations personally (which also impacts the rate of adoption in the classroom). For example, faculty members may utilize instructional technology within their classrooms by developing a Web-based project for their students to use on the computer or by incorporating PowerPoint slides into their lecture format. If the faculty members do not use the innovations for their personal use, then they may be more likely to disregard the use of the innovation. A review of the literature identified that:
…in a decentralized system, innovations tend to fit more closely with individual users’ needs and problems. Users seek information through personal networks or colleagues, participate in making decisions about what sort of training and support they would like to see as they learn more about the innovation, and then tailor it to their own specific needs as they begin to develop the expertise, knowledge, and skills to use it effectively. As a result, a decentralized diffusion system is closely geared to local needs. A solution that works for one particular school may not be suitable for another, even within the same school district. (Sherry, 1997, p. 2)

There must be a reason for using an innovation before adoption and implementation can or will take place. For example, if an institution gives faculty members incentives to implement a new innovation into their teaching, this may be reason enough for the faculty members to learn about the new innovation and apply it to their learning and teaching. However, other faculty members may not feel the incentives are worth the time and hassle of learning and implementing the new innovation and may reject the innovation. Faculty members who learn about new innovations and apply them into their personal use are more likely to apply new innovations into their teaching practices.

A review of the literature addressed a project that took place in a Dutch institute of higher education that investigated a specific innovation in a higher engineering education context (Verloop et al., 2001). The researchers from the institute examined the conceptions held by teachers about teaching and learning and examined the relationship between these conceptions and the goals of the curriculum innovation project (a project that was more student-centered; Verloop et al., p. 454). The results indicated that all teachers “supported
the proposed curriculum innovation, and expressed a desire to implement a ‘student-centered’ approach’ (Verloop et al., p. 455), although this meant that teachers adopting the innovation would have to provide increased small group time to support student activities. The researchers from the institute also reported that “most teachers appeared to be very skeptical about students’ abilities to perform self-regulated activities without teachers’ constant support and control” (Verloop et al., p. 455).

The book, *Strategies for Planned Change*, identified the resistance to change and the specific barriers that may increase and/or decrease change (Zaltman & Duncan, 1977). There were many categories of resistance, such as cultural barriers, social barriers (e.g. conflict, conforming to norms), group solidarity, and rejection of outsiders (Zaltman & Duncan). A different review found that “resistance is one of those signals; the effective change agent must be able to interpret its causes and adjust the implementation strategy accordingly” (Ellsworth, 2000, p. 167).

Faculty buy-in to technology integration may have a major influence on technology integration in an organization as a whole (Chickering & Ehrmann, 1996; Chuang, Thompson, & Schmidt, 2004; Hagenson, 2001). This means that faculty who see the importance of technology integration for their students’ learning outcomes may facilitate an organizational change. If an organizational change does not occur and faculty integrate technology as they see fit, then the lack of coordination of this diverse integration of technology may not enhance faculty members’ ability to communicate the materials. This may, in turn, hinder student learning and understanding of the required content.
Teacher Beliefs and Practice

A critical review of the literature that compared and contrasted various research studies on teacher and faculty beliefs, their practices, and the relationship between their beliefs and practices was identified and analyzed for this literature review (Kane et al., 2002). It was found that there is a “contention that research that examines only teachers’ espoused theories of action is at risk of telling half of the story” (Kane et al., p. 184). The findings from the critical review were explained using Argyris and Schon (1974) and later Argyris, Putnam, and McLain Smith (1985, as cited in Kane et al.).

The review revealed that “the espoused theories of action of academics have not been distinguished from their theories-in-use in some studies” (Kane et al., 2002, p. 177), and that there were “several unsupported claims about university academics’ teaching practices” (Kane et al., p. 177). The authors found that their review reinforced their realization that “there are synergies between the interaction of teacher beliefs and teaching practice in university and primary and secondary school contexts” (Kane et al., p. 203). This critical review of the literature guided this section on teacher beliefs and teacher practices.

Studies That Assumed Teachers’ Practice from Teachers’ Beliefs

The studies that assume teachers’ practice from teachers’ beliefs are only telling half of the whole story about the teaching process (Kane et al., 2002). For example, Samuelowicz and Bain (2001) suggested “that shifts from teaching-centered to learning-centered orientations are possible, and that shifts occur at varying rates” (p. 322).
“Changing deep-seated conceptions or beliefs is recognized as a difficult process and one which normally takes place over an extended period” (Kember et al., 2001, p. 404).

The spectrum ranged from limited conceptions to more open-ended conceptions (Entwistle, Skinner, Entwistle, & Orr, 2000). In contrast, the two sub-scales (Information Transmission/Teacher Focused [ITTF] and Conceptual Change/Student Focused [CCSF]) “are not considered to represent two ends of the same continuum, but to be relatively independent of each other” (Prosser & Trigwell, 1997, p. 27). Studies were located and briefly presented in chronological order below, starting with the details of one engineering study: There were three studies identified that researched engineering faculty.

One research study was conducted “as part of a curriculum innovation project in higher engineering education” (van Driel et al., 1997, p. 106) in order to examine teacher’s craft knowledge and “increase the chance of a successful innovation” (p. 112). Craft knowledge was discussed and defined earlier in this chapter (Faculty Preparation: Teacher Knowledge). The project took place in the Rijswijk Institute of Technology in The Netherlands where there were courses in technical disciplines (e.g., electrical and mechanical engineering; van Driel et al., p. 110). There was 60 participants in the study with different characteristics: “Almost two thirds of them were graduated engineers from a university of technology or an institute of higher professional technical education . . . the rest held a master’s degree or a doctorate in subjects such as mathematics, physics, economy, law, chemistry, or English” (p. 113). A semi-structured interview structure and a questionnaire based on the interview questions were used to “acknowledge the expertise of
the respondents on the subject and to allow them to tell and discuss ‘their own stories’” (p. 113) and identify additional issues.

An interpretive phenomenological perspective on the data categorized “specific conceptions of teaching” (vanDriel et al., 1997, p. 114). They reported that the teaching conception that occurred “most frequently [almost two thirds] was labeled student-directing” (p. 114). This conception of teaching was characterized by an “intensive relationship of teachers with their students” (p. 114), which “may be represented by the image of students being engaged in different sorts of learning activities, which are carefully being planned and controlled by teachers in order to cover a fixed amount of subject matter” (p. 115). There were two other conceptions of teaching reported from the study, teacher-centered conceptions and student-centered conceptions, although they comprised about one quarter (teacher-centered) and one-tenth (student-centered) of the answers from teachers.

Another research investigation identified the disjunction between lecturers’ claimed educational practice and their conceptions of teaching (Murray & MacDonald, 1997). The researchers conducted a preliminary study, using semi-structured interviews, of 13 business lecturers in London. They explored “the common themes of teaching methods adopted in lectures and tutorials, influences on teaching methods used, perceived purposes and types of assessment, use of feedback, and teaching strategies, and their review and development” (p. 337). The conceptions of teaching identified from their study were concerned with four main areas:

1. Imparting knowledge,
2. Enthusing, encouraging, and motivating students,

3. Facilitating student learning, and

4. Supporting students (Murray & MacDonald, p. 341).

These findings were compared and contrasted with Samuelowicz and Bain’s (2001) findings (which are discussed at a later stage in this review), and Murray and MacDonald identified that there “[was] an overlap between categories, particularly between facilitating learning and motivating students” (p. 341). They did not identify, however, the disjunction between lecturers’ conceptions of teaching and their claimed educational practices, although they did explain how they could close this gap by encouraging “systematic reflection[s] on the process of learning and teaching and by encouraging debate on the issues, so a greater awareness of the difference between espoused theory and theory-in-use [Argyris & Schon, 1978] is developed” (p. 345).

A mixed methods investigation was conducted to study the “relationship between university teachers’ perceptions of the teaching environment and their approaches to teaching” (Prosser & Trigwell, 1997, p. 26). In the qualitative phase of the study, interviews with 13 teachers of first-year university chemistry and physics courses in two Australian universities were conducted in order to identify university teachers’ perceptions of the teaching environment. In the quantitative phase of the study, comprising a sample size of 46 teachers from several Australian universities, results of the Approaches to Teaching Inventory (described in Trigwell & Prosser, 1996a, 1996b) and the Perceptions of the Teaching Environment (PTE) analyzed using factor, correlational, and cluster analysis. The PTE was developed from analyzing and categorizing findings from Phase 1. Prosser
and Trigwell reported contentions from the first phase of analysis, “that teachers are more likely to adopt a Conceptual Change/Student Focused approach rather than an Information Transfer/Teacher Focused approach, if they:

- Perceive that they have some control over what and how they teach,
- Perceive their class sizes are not too large to prevent engagement in interaction with their students,
- Perceive that their students are able to cope with the subject matter,
- Perceive that teaching is valued in their department, and
- Perceive that their academic workload is appropriate” (p. 29).

The second phase of the analysis reported the correlational, factor, and cluster analysis from the survey data. Prosser and Trigwell (1997) found that the correlations between the Approaches to Teaching variables and the Perceptions of the Teaching Environment variables suggested that “those teachers who adopt a Conceptual Change/Student Focused approach to teaching perceive that their class sizes are not too large and that their department values teaching” (p. 30). From the principal components factor analysis of the variables (Approaches to Teaching variables and the Perceptions of the Teaching Environment variables), the researchers found that there was a coherent relation between the variables, that “a Conceptual Change/Student Focused approach is linked to perceptions of having control over what is taught and how it is taught, of class sized not being too large to engage in interaction, and of departments valuing teaching” (Prosser & Trigwell, p. 31) and that “an Information Transmission/ Teacher Focused approach to teaching is linked to a perception that the department values teaching” (Prosser...
The results from the cluster analysis were “consistent with the idea that teachers who adopt a Conceptual Change/ Student Focused approach to teaching generally perceive their teaching environment positively and those not adopting such an approach generally perceive the environment negatively” (Prosser & Trigwell, p. 32-33).

Overall, Prosser and Trigwell (1997) suggested that “it is the variation in Conceptual Change/ Student Focused approach to teaching that relates most systematically to variations in perceptions of environment, while variations in the Information Transfer/ Teacher Focused approach have little systematic relationship” (p. 33). This was the first study that examined the relationship between teachers’ perceptions and the approaches to university teaching, and it did not document any classroom observations of the university teachers to compare and contrast with the teachers’ espoused beliefs. Consequently, they also were telling only half of the story.

Kelly’s Repertory Grid (1955) has been identified as an appropriate methodology for eliciting “‘personal constructs,’…from an individualized conception of professional practice” (Hillier, 1998, p. 38) to make explicit “the tacit, implicit, and idiosyncratic ways of looking at practice for each individual” (Hillier, p. 39). Hillier also identified that Kelly’s Repertory Grid (1955) was “an appropriate method for the identification of informal practitioner theory” (p. 39). Hillier used a set of elements during a three part interview process “to draw out constructs which [were] then analyzed for similarities in order to form a representation of a person’s construct system” (Hillier, p. 40), to “[enable practitioners] to identify the implicit and tacit beliefs which they hold about their work” (Hillier, p. 48) and to, “establish these as informal practitioner theory” (Hillier, 48). A
A common theme identified from all the respondents was that of “student-centeredness and caring” (Hillier, p. 46), which was “superordinately construed and directs practitioners’ informal theory about their practice” (Hillier, p. 48). The five tenets identified by the study were:

1. A student centered philosophy.
2. Resistance to any change in practice which threatens the tenets of student-centeredness.
3. The “ethos” of basic skills practice.
4. Reflection on practical aspects of basic skills.

Although Hillier explained that, “the ethos of their practice implied a deeply held belief of what basic skills practice should be” (p. 49), there were no discussions of observations of the teachers’ practice. She concluded that the methodology she used for analysis “may provide the means by which formal theories of adult education can be informed by practical knowledge” (Hillier, p. 50).

In contrast, Gibson (1998) researched her own classroom at the City University of New York, with the aim of suggesting that “encounters with self as a cultural entity, as teacher, and as learners are critical components in the construction of culturally relevant pedagogy” (Gibson, p. 361). She audio taped her classroom discussions to analyze her cross-cultural perspectives on child-rearing, her personal beliefs, and traditional educational ideologies. She identified that she had engaged in Osborne’s “‘practice-theory
dialectic’, a behavior that underlies construction of culturally relevant pedagogy” (Gibson, p. 361). By engaging in this behavior, Gibson was able to “break the compact of silence” by bringing “deeply embedded personal prejudices into the realm of articulated consciousness” (Gibson, p. 368).

Although, Gibson (1998) observed actual classroom practices, it was Gibson, herself, that observed her own classroom practice. Consequently, this analysis was considered to be that of her espoused beliefs about her classroom practices, not her observed classroom behavior. Her research was valuable in that she was able to reflect on her own teaching and learning and her analysis enabled her to engage “in a practice typical in teacher education in which [she] was attempting to separate discussions of theory, or ideology, from practice” (Gibson, p. 363). She found that she “was unable to share with [her] students that part of [her] cultural identity which harbors feelings of racism” (Gibson, p. 367). In uncovering these prejudices, Gibson was able “to bring deeply embedded personal prejudices into the realm of articulated consciousness” Gibson, (p. 368) that enabled her to engage in quality discourse about cultural identity with her students. This approach of action research empowered Gibson to improve her teaching and learning.

In Australia another study addressed the need for “university teachers to reflect on their practice” (Ballantyne, Bain, & Packer, 1999, p. 238). The aim of their research was “to reveal the insights of academics actively engaged in effective teaching practices rather than to conform with a theoretical or philosophical stance” (p. 239). They focused on using narratives or stories as alternative methods for explaining and describing the complexities
of teaching, “which preserves the context in which the teaching occurs and the beliefs and values which underpin it” (p. 238).

The researchers contacted all 40 Australian university department heads, deans, and teaching development unit directors and “asked them to nominate academics whom they perceived to have exemplary or noteworthy teaching practice” (Ballantyne et al., 1999, p. 239). The respondents were also asked to identify the reasons for the nominations. These reasons were analyzed and formed major keywords about the teaching practices and contexts of the nominees. These major key words informed the general questions that were asked to the nominees. A total of 1,996 academics that were nominated and 708 nominees that responded to the questions. From these respondents, 44 exemplary university teachers were chosen “in order to represent a range of disciplines, teaching activities, and orientations to teaching” (Ballantyne et al., p. 239). The university teachers were interviewed informally by semi-structured interviews using a narrative inquiry method (p. 239). The full narratives are described in Ballantyne, Bain, & Packer, 1997.

The researchers found that in the context of exemplary practice, lectures are still identified as the most common type of teaching (Ballantyne et al., 1999). They also identified that linking practice, theory, and motivating student interests are the most cited teaching objectives. Overall, they affirmed that “the teaching methods most frequently cited as innovations are those which involve the use of computer technology, including computer-based learning, multimedia programs, the use of the Internet and computer simulations” (Ballantyne et al., 1999, p. 243). They also identified dominant themes that prevailed from the full narratives or stories, which were: “a love for one’s discipline (and a
desire to share it with others), valuing students and their perspectives, and making learning possible. These are the hallmarks of teaching that is both discipline-focused and student-centered” (p. 243).

The researchers found that “the academic’s stories in particular provide a rich medium for stimulating further reflection on practice, comparison of alternative approaches, and exploration of the links between beliefs and practices” (Ballantyne et al., 1999, p. 255). These findings were similar to Gibson’s (1998) findings, in that reflecting on one’s own practice can help uncover the mix of personal beliefs, pedagogical practices, and educational ideologies. However, neither Ballantyne et al. (1999) nor Gibson identified attributed beliefs, as defined by Aguirre and Speer (2000), so they both told only half of the story of teacher’s espoused beliefs and their classroom practices.

A different research investigation sought to “examine the relationship between lecturers’ approaches to teaching and their conceptions of good teaching” (Kember & Kwan, 2000, p. 469). The researchers gathered data through semi-structured interviews with 17 lecturers from three different university departments: social sciences, engineering, and paramedical (p. 473). Unusually, the researchers “initial exploration focused upon teaching methods or techniques, as most of the lecturers had described or used terms like lecturing, use of handouts, class discussion, or case studies” (Kember & Kwan, p. 474-475), before they “embarked upon a deeper examination of the transcripts to see if there was a more subtle characterization of approaches to, or strategies for, teaching” (Kember & Kwan, p. 475).
Kember and Kwan (2000) found that two broad approaches taken by lecturers were “characterized by a one-dimensional motivational component [named motivator] and a five-dimensional strategy component [named instruction, focus, assessment, accommodation for student characteristics, and source of experience/knowledge]” (p. 475). The two major categories that described the conceptions of teaching were “teaching as transmission of knowledge” and “teaching as learning facilitation” (Kember & Kwan, p. 483-484). The researchers cross-tabulated these teaching conceptions of the lecturers with their approaches to teaching and found “a high-level of correspondence [89.5%] between a lecturers’ conception of teaching and his/her approaches to teaching” (Kember & Kwan, p. 485), thus suggesting “that approaches to teaching are strongly influenced by the lecture’s conception of teaching” (p. 489). However, since they failed to observe classrooms their findings are limited.

Kember, Kwan, and Ledesma (2001) sought “to examine the teaching of adults in a university to see if lecturers recognized any differences between their adult and other students and whether and, if so how, they adapted their teaching” (p. 393-394). The researchers gathered data through semi-structured interviews with 17 academics from three different university departments in Hong Kong: social sciences, engineering), and paramedical (p. 473), using methods and approaches similar to those described by Kember and Kwan (2000). The “initial analysis focused upon whether the lecturers perceived differences between their adult and full-time students, and if so what these were” (Kember et al., p. 395). The researchers, then “re-examined the transcripts to see if there was any
pattern to these different teaching strategies following homogenous interpretations of the strengths and weaknesses of the two groups of students” (p. 397).

The research found three “categories of the way in which teaching approaches were adapted to accommodate the differing student characteristics” (Kember et al., 2001, p. 397): catering for weakness/teaching to strength, treating both groups in the same way, and remediating weaknesses. The researchers then re-coded and re-read the transcripts and identified two major categories of teaching conceptions. The two major categories were “teaching as transmission of knowledge” and “teaching as learning facilitation” (Kember et al., p. 399-401). The researchers cross-tabulated these “teaching conceptions of the academics with their orientations towards differing student characteristics” (Kember et al., p. 402) and found “a high-level of correspondence [82.3%] between a lecturers’ conception of teaching and the way in which the teaching accommodated the differing characteristics of adult and other students” (p. 403), thus suggesting “that the constructs are related” (p. 403).

Samuelowicz & Bain (2001) interviewed “39 academics from three universities in Brisbane, Australia representing a range of disciplines” (p. 301) in order to re-evaluate the five-level classification of belief dimensions and orientations described in their 1992 paper. Their empirical work with five qualitative dimensions “can be ordered in such a way as to contrast variants of knowledge-transmission (teaching-centered) with variants of learning facilitation (learning-centered; p. 299-300). Similar to their analysis from their 1992 paper, Samuelowicz and Bain “conducted a three phase grounded analysis to establish and describe the teaching and learning orientation” (p. 304). They interviewed respondents
about teaching and learning and then analyzed the findings into broad characteristic trends. They reported the same orientations between their 1992 paper, although one orientation was divided into two varying orientations “because there were sufficient cases of each to make their differences apparent” (p. 308); “Facilitating learning” was divided into “providing and facilitating understanding and helping students develop expertise” (p. 308).

The seven belief orientations identified by this study were:

- Imparting Information
- Transmitting Structured Knowledge
- Providing and Facilitating Understanding
- Helping Develop Expertise
- Preventing Misunderstandings
- Negotiating Understandings
- Encouraging Knowledge Creation

The authors indicated that these orientations did not provide a “contextualized sense of an individual academic’s beliefs and practices” (Samuelowicz & Bain, p. 312). Therefore, they used illustrative stories to describe how these academics teach and “to demonstrate how dissimilar these two orientations are” (Samuelowicz & Bain, p. 312). The authors did not observe the teaching practice; they only inferred their teaching practices from their interview responses.

The last research study in this section also examined teachers’ beliefs and organized their findings into a spectrum arranged from teacher-focused, content-oriented beliefs to student-focused, learning-oriented beliefs (Entwistle et al., 2000). The spectrum ranged
from surface level learning (teacher-focused, content-oriented), where the teacher focuses on transmitting content to the students, at one end of the spectrum, to deep, meaningful learning, where the teacher focuses on engaging the students actively in learning-oriented activities in order for the students to develop their own understanding of the course material. Entwistle et al. found that teachers may not be aware of ways in which to move throughout the spectrum. Kane et al. (2002) noted that, “the use of methods to directly observe the teaching practice of the participants might have shed some light on the effect of teaching conceptions on teaching practice at the university level” (p.192).

*Studies That Did Not Report Teaching Practice Based on Espoused Beliefs*

The studies that did not report teaching practice based on espoused theories of action were also telling only half of the story (Kane et al., 2002). These studies “were careful not to make claims regarding teaching practice” (p. 192) because they did not access teaching practices directly. These studies were identified and are briefly presented in chronological order below.

Willcoxson (1998) interviewed 15 academics in order to examine “the relationship between the way academic staff like to learn and the way they like to teach and the reasons they use the teaching strategies they adopt in lecture” (Willcoxson, 1998, p. 59). Willcoxson did not observe the teaching practices of the academics in question: “The descriptions by these academics of their own teachers and their own teaching are reflected in the descriptions of their teaching provided by their students” (p. 65).

Pratt, Kelly, & Wong (1999) used questionnaires “to inform the process of evaluating teaching in higher education in Hong Kong and to contribute to the research on
the cross-cultural application of models of teaching effectiveness” (p. 241). Their findings identified “five themes:

1. The role and value of ‘foundational’ knowledge in undergraduate education;
2. Appropriate roles and relationships for teachers and students;
3. The process of teaching;
4. Ways in which faculty characterize Chinese learners;
5. Attributions of responsibility for effective teaching” (p. 245).

Pratt et al. conducted the study to provide “more evidence that conceptions of teaching, learning, and knowing are deeply rooted in specific cultural antecedents and social structures” (p. 241). Partly as a result, they found that “the entire process of evaluation must be recognized as a cultural and value-laden interpretation of all that we observe” (p. 257).

Similarly, Samuelowicz and Bain (2001) and vanDriel et al. (1997), reported earlier in this chapter, discussed the need to understand the disjunction between teacher beliefs and teacher practices (see above for further details). Kane et al. (2002) commented: “Given this insight, perhaps they could have taken the opportunity to make explicit links between the conceptions they found and the teaching practice of their participants” (p. 193).

Studies That Examined the Relationship Between Espoused Beliefs and Teaching Practices

This last section identifies and briefly presents in chronological order the studies that were located that examined the connections between teachers’ espoused theories of teaching and their teaching practices (those that are trying to tell the whole story; Kane et al., 2002).
In the first study, Saroyan & Snell (1997) examined three types of lecturing styles “in the context of current conceptions of teaching and pedagogical principles (p. 85). Kane et al. (2002) noted that “Saroyan & Snell described what some researchers have termed the conceptions of teaching by relating the aims of the lecturers to previously reported frameworks” (p. 194). They observed seven, one-hour lectures in an “introductory Dermatology Program for second-year pre-clerkship students in a Canadian medical school” (p. 90) and disseminated a questionnaire to the lecturers before their instruction “to establish the scope of instructional plans” (p. 90). Then they videotaped each lecture and collected student evaluation data “after each instructional block” (p. 90).

Saroyan and Snell (1997) made three categories for encoding: content, pedagogy, and other (p. 90-91). They also compared student evaluations of the lectures using a Tukey HSD test and an ANOVA. For example, the second lecture was described as “context-driven,” (Saroyan & Snell, p. 99), where “greater pedagogical expertise is evidenced by a broader conception of teaching in which the transmission of culture and training skills are as evident as the conception of teaching as producing conceptual change (Scardamalia & Bereiter, 1989)” (Saroyan & Snell, p. 100). The researchers did not make a direct link between teachers’ espoused beliefs and their classroom practices. However, they did conclude that, “a lecture can be as effective as any other instructional strategy so long as it is appropriately suited to the intended learning outcomes and is pedagogically planned and delivered” (Saroyan & Snell, p. 102).

Gibson’s (1998) study, discussed in the prior section, also examined the relationship between beliefs and practices. Gibson identified that her “belief system contained no racial
biases while [her] behavior support[ed] racism by practicing the compact of silence” (p. 368). She was able to “unravel the tangled web of personal beliefs, cross-cultural perspectives on child-rearing, and traditional education ideologies which informed [her] teaching practices” (Gibson, p. 361). As a result, she was able to identify inconsistencies between her espoused beliefs and teaching practices (e.g., creating “programs which do, indeed, open up to cultural difference” (Gibson, p. 366).

Hermes (1999), at a university in Germany, studied “how students and teachers are guided in university classes by their self-images and how these determine their behavior in such session” (p. 197). Hermes adopted action research with subjective theories in order “to become aware of their own self-concepts, of the roles they played during the sessions, especially with a view to active participation [e.g. from the side of the students], to teacher-student and student-student interaction [e.g. teacher tried to reduce dominant role as an instructor]” (p. 199). The teacher and the students used videos, diaries, and interviews to improve their teaching and learning experiences and “learnt ways and means . . . to guide wherever necessary, but to yield ‘power’ to the students, to let them determine the course of a session and give them free range in their activities” (Hermes, p. 203).

Quinlan (1999) examined “the educational beliefs of eight academic historians . . . in the context of their department, the university and the history of the discipline” (p. 447). Quinlan “observed departmental meetings and faculty seminars, sat in on classes and intensively interviewed eight academics about their perceptions of the teaching of their subjects and the local departmental [and faculty] culture” (p. 448). The study aimed “to prompt a new way of thinking about academics’ beliefs about the teaching of their subject
matter and to illustrate this conceptual framework by reporting on the scholarly aspects of
teaching beliefs” (Quinlan, p. 449). Illustrative case studies were used to identify
differences and similarities in academics’ beliefs through their beliefs, goals, teaching
approaches, and student evaluation. Quinlan found that:

…a number of academics described part of their teaching job as inspiring students
. . . stimulating them to further inquiry . . . conveying information, [and] teaching
students what to do with the information . . . [These academics] described themselves
as primarily didactic in their approach” (p. 453).

Martin, Prosser, Trigwell, Ramsden, & Benjamin (2000) report an empirical study
of 26 university teachers that examined “what it is that teachers within their classrooms
intend to constitute for their students to learn [‘object of study’] and the relation between
[the object of study] and how teachers intend to approach their teaching” (p. 389). Martin et
al. used in-depth, semi-structured interviews to probe “the teacher’s conceptions of their
object of study and their approach to teaching in relation to that object” (p. 391). “On the
basis of these interviews a hypothesis was formed as to how the teacher would teach in the
classroom” (Martin et al., p. 390-391). They observed two sessions and found that there
was “no observed inconsistency between the teachers’ intentions and their practices”
(Martin et al., p. 409). They also identified that “the empirical relationship between the
categories indicate a clear relationship between the teachers’ intended objects of study and
their intended approaches to teaching” (p. 409). Martin et al. found “that it is not just how
we teach that is important to student learning, nor what we teach, but what it is we
constitute in particular teaching and learning contexts” (p. 409). Martin et al.’s research is also examined in the other chapters of this dissertation.

Hativa, Barak, & Simhi (2001) examined “the beliefs and general pedagogical knowledge of [four] exemplary university teachers regarding effective teaching strategies, the extent to which they use various of these strategies, and the relations between their beliefs and knowledge to their classroom practice” (p. 703-704). Hativa et al. collected data in a research university in Israel through teacher interviews (semi-structured precourse interview and an open post-unit interview), student interviews, videotaped classes, effective questionnaires, and materials distributed to the students by the instructor. They found that “one way in which the pedagogical knowledge of good and poor teachers differs is in the number of effective classroom strategies with which they are familiar” (Hativa et al., p. 722). Their study indicates that “there is a good, but far from perfect, fit between these teachers’ beliefs and knowledge concerning effective strategies and their classroom practice” (p. 725). Kane et al. (2002) noted that, “This study, one of the most thorough we have reviewed in its attempts to capture the complexity of teaching, proposes explanations for the differences between poor and good teachers” (p. 195).

Summary

This review of the literature identifies that there is a lack of literature that explains or describes engineering faculty members’ faculty development and efforts to improve their teaching, including the use of technology. The common preparation of engineering faculty as instructors is experience and mentoring as a teaching assistant during a graduate program, whereas faculty members in colleges of education provide courses and programs
to prepare K-12 teachers and education faculty to teach. Professional development is closely linked to teacher beliefs, knowledge, and practice so definitions of these were researched and presented. Faculty have many roles in universities, including instruction, which has a low priority and that causes stress that is related to low quality instruction. Technology has been used innovatively to address this low quality and also to increase access to higher education. The complex process of adoption was reviewed including Chickering and Ehrmann’s (1996) Seven Principles of Good Practice in Higher Education. Entwistle, Skinner, Entwistle, & Orr (2000) noted that, “One the most intractable problems both in teacher education and in staff development in higher education is how best to utilize theoretical constructs and research evidence” (p. 24).

The final section of the review examined research on teacher beliefs, teacher practices, and the relationship between teacher beliefs and teacher practices in higher education. Additionally, studies on teacher beliefs and practices, including research informed by K-12 literature, were included in this literature review to provide a rich understanding of the ways to describe teaching (Kane et al., 2002; Kember, 1997). Three studies of engineering faculty were located and reviewed. One high quality study of the pedagogical knowledge and beliefs of high quality university instructors identified a fit between instructors’ espoused beliefs and classroom practices. This review was unable to identify any studies that examined faculty members’ espoused beliefs and the relationship between their espoused beliefs and their classroom practices using technology.
CHAPTER III

METHODOLOGY

Introduction

This chapter presents the research methods and approaches for the research study. The chapter begins by describing the participant researcher and the EDE context with the aim of describing the context for the case studies. Next, the methods of the first case study are described, including the aim, data collection methods, participants, and the semi-structured interview protocol design. Then, I explained the items that were changed before conducting the second case study, such as the adding of the technology-specific questions to the interview protocol. Next, the methods of the second case study are described, including the aim, data collections methods, participants, and the semi-structured interview questionnaire. Subsequently, the methods for analyzing the case study data is described, including the five stages of analysis. Finally, the ethical considerations are explained for the research investigation.

The methodology begins with epistemology because the study aims to provide a non-dualistic, phenomenographic perspective of engineering faculty. Epistemology is the branch of philosophy that “is concerned with the origin, nature, limits, methods, and justification of human knowledge” (Hofer, 2002, p. 4). In this study, epistemology relates to the ways in which engineering faculty know or understand.

A non-dualistic view, according to Martin et al. (2000), describes meaning as created from the relationship between the context and the individual. These meanings/experiences from the internal relationships between people and the world are the
ways in which a phenomenon is experienced by people and the ways that people experience a certain phenomenon (Marton & Booth, 1997). Similarly, from a phenomenographic perspective, “knowledge cannot exist in a context independently of the knower, rather knowledge is constituted in the relationship between the knower and the context” (Martin et al., p. 388). This means that teachers create meanings/experiences “within the learning and teaching context, and attempt to bring their students into a relationship with that knowledge through their teaching in that context” (Martin et al., p. 388; Marton & Booth).

Phenomenography aims to identify, formulate, and tackle certain research questions that are relevant to understanding and learning in educational settings. In employing a phenomenographic perspective, I described all variations in the ways of experiencing the phenomena. From this perspective, research was a way of experiencing something, such as the internal relationship between the experienced and the experiencer (Marton & Booth, 1997).

Research Approach

This research study employed qualitative research, “an umbrella concept covering several forms of inquiry that help us understand and explain the meaning of social phenomena with as little disruption of the natural setting as possible” (Merriam, 1998, p. 5). The qualitative approach for this phenomenographic study was single case study design, because the phenomenon to be examined was intrinsically bound (limited) to two engineering faculty members (Merriam): The study examined two faculty members’ beliefs and classroom practices using technology within their classroom context, a technologically
equipped classroom, without any disruption of the complexity of the case study or the natural surroundings in order to identify and explain possible disconnects between the engineering faculty members’ espoused beliefs and classrooms practices using technology.

The research aimed to provide two case studies, each of one engineering faculty member’s espoused beliefs and classroom practices with technology. “The case study format has the advantage of context-sensitivity, meaning that [I] can probe more tellingly into connections between local conditions and individuals’ attitudes or behaviors than would be possible in a multisite study” (Serow, 2000, p. 451). The case studies were interpretive, in that the stories of the two engineering faculty members’ that emerged from the data collected were used to challenge the theoretical assumptions held prior to the data gathering (Merriam, 1998).

The identification and description of the first case study phenomena resulted from a series of iterations (adapted and modified from Yin, 2003, p. 121):

- Developing the research question and the research instruments;
- Comparing the findings from the first case study against the research question using the data collected from the research instruments.

In order to explain the phenomena in more depth, I established further iterations that were applied in the second case study analysis:

- Revising the research instruments;
- Comparing the findings from a second case study against the research question using the data collected from the revised research instruments;
• Comparing the findings from the first case study against the second case study.

(Yin)

These iterations were helpful in explaining more thoroughly how engineering faculty members’ espoused beliefs related to their classroom practices using technology. The first case study also piloted the interview and observation schedules for the second case study.

In this research study the data was triangulated and member checking was implemented in order to improve the reliability of the case studies. Data were gathered through semi-structured interviews from faculty members, observations of faculty members’ classroom practice, student focus groups (perceptions of faculty practice), document analysis, and the researcher’s journal. The participants for both case studies were asked to check their completed transcriptions and to respond by a certain date to ensure correct and accurate transcription results. The data gathered about the problem were analyzed and interpreted to describe the phenomenon (Merriam, 1998). Following analysis, I was able to describe the story of two engineering faculty members from one midwestern university.

The Participant Researcher and Engineering Distance Education

As the participant researcher in this case study, I drew upon my background experiences to identify the engineering faculty members’ espoused beliefs and classroom practices using technology. As an undergraduate, I became interested in technology integration while participating in an educational technology course that prepared students to integrate technology into their teaching.
I continued my education in the field of educational technology in a Curriculum and Instruction master’s degree program at a different midwestern university. As a master’s student I was employed as one of two faculty support staff members and assisted faculty in the College of Education with technical and software support and facilitated live training sessions. The focus of my master’s thesis was to understand in what ways university faculty members integrate technology into their teaching (Hagenson, 2001).

After I completed my master’s degree, I pursued my doctoral degree at this midwestern university. I served as a teaching assistant for an undergraduate course, Introduction to Instructional Technology, for pre-service teachers. Following that, in order to continue working with both faculty members and students as I had done during my master’s work, I pursued employment at the EDE unit in the College of Engineering. I was one of two graduate assistants who served in various roles for EDE’s courses: instructional support specialist, teaching assistant, and distance education coordinator. We also met the needs, in relation to their courses, of all faculty and students.

The EDE context, which was briefly described in Chapter 1, was the context for both case studies and will be explained in greater detail in this section. During winter and summer break at this university, EDE staff members (including myself as a graduate assistant) and other student workers prepared for the upcoming semesters. Distance education rooms were arranged at the same time that course offerings were finalized; any faculty member in the university had the opportunity to use EDE’s services by negotiating with EDE staff.
Student producers and EDE technical staff (myself and two other staff members) prepared the EDE classrooms by cleaning the rooms, upgrading technologies (both software and hardware), and adding specific software requested by faculty members to the Instructor and Tablet PC. Next, the three staff members prepared all WebCT courses for course delivery. A pre-established template was added to each WebCT course; the template was developed as a standard template for all WebCT courses (I developed the template with one other graduate student) and included placeholder icons for the syllabus, streaming lectures, ftp downloads, lectures notes, and in-class notes. After the template was added to each course, the student workers added relevant instructor information, such as the instructor’s name, the course name, instructor email, and the course website (if any).

Following the preparation of the EDE WebCT courses, the EDE staff members emailed all of the professors one week before the semester started. Professors responded to the email by completing an instructor form, which informed EDE when and if they wanted to release their streaming lectures to on- and off-campus students, what their website URL was, if they had a teaching assistant (TA), and if they wanted their on/off-campus students to access WebCT. The professors sent various emails and attachments to the EDE staff before the semester, some of which included the course syllabi, course websites, course information updates, and course information to deliver to the on/off-campus students.

For each of the courses, EDE staff members posted the appropriate materials to WebCT as well as enrolled off-campus students manually into their WebCT courses (once students registered for their distance education courses). At the same time, EDE professors met face-to-face or by telephone with technical staff for support (e.g., to help them add all
of their on-campus students into their course and to help them on-on-one with technical support). Any faculty member in the university had the opportunity to use EDE services by negotiating with EDE staff.

Student producers recorded and facilitated each of the EDE courses. The student producer prepared faculty members’ courses by turning on their microphone, opening their classroom, uploading their lecture file (a file provided by the faculty member via email, website, pen drive, etc.), and starting Camtasia software on the Tablet PC, which recorded the Tablet PC screen. The resulting video was exported and then posted as a high resolution (hi-rez) lecture beside the original low resolution (low-rez) lecture (the lecture that the student producer recorded with the three mounted cameras) within WebCT. Therefore, any of the students could choose to view either a low-rez lecture or a hi-rez lecture for each of their lecture sessions. On-campus students were also required to attend the lecture in person.

Then the student producer returned to the control room (located beside the EDE classroom) to record the class, waited until the faculty member said that he/she was ready, and then prompted the faculty member to begin the course by running three introduction slides (the intro sequence), which included music and ended with a picture of the professor on the TV screen in front of the professor. This intro sequence was used at the beginning of each lecture and indicated the start of a new lecture. After the lecture ended, an exiting sequence, which included music and the same three slides in reverse order, was played to indicate to the students that the lecture was over.
The student producers and EDE staff members posted lecture notes into their assigned WebCT courses before and/or after they completed the video production for on/off-campus students. The EDE technical staff members answered emails, answered phone calls, checked streaming lecture links, and communicated with the faculty members’ on- and off-campus students. They also troubleshooting various technical issues with on- and off-campus students who were having technical problems with their WebCT courses.

At the end of each semester, EDE faculty members who taught that semester were sent an email requesting information about students who had incompletes in their course. After identifying students with incompletes and the planned date of completion, the EDE technical staff members retained the streaming lecture links until that completion date. As a service provided to the faculty, each semester the EDE staff members made a copy of the course materials and lectures for the professors so that they would have an archived copy of their course. These processes were repeated each semester.

Methods of the First Case Study

The aim of this first case study was to explore one engineering faculty member’s espoused beliefs, his observed classroom practices using technology, and his students’ perceptions of his classroom practices. One tenure track faculty member from the College of Engineering at a midwestern university was the focus of this investigation. This college was selected because of the various beliefs and classroom practices held by faculty and because of its leading EDE unit that supports technology infusion.
Data Collection Methods and Participants

During the Spring 2006 semester, I invited one faculty member, Dr. K, to participate in this case study research. Dr. K was selected from the complete list of faculty members provided by the College of Engineering. This particular faculty member was selected because he utilized technology applications in his course as a means for reaching students at a distance and for enhancing his students’ ability to understand the course materials. I identified Dr. K as being a typical engineering faculty member who was willing to participate in a research investigation about espoused beliefs and classroom practices using technology. He was selected also because of his involvement with EDE: he started teaching with EDE in 2001 and had taught a course four times through EDE. The research started in January 2006 (please see the timeline in Table 3.1). The data collection methods and allocation of participants are outlined in Table 3.2.
Table 3.1. Timeline for the First Case Study Research with Key Events for the Course and Research

<table>
<thead>
<tr>
<th>Date (2006)</th>
<th>Research key events</th>
<th>Course key events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>Beginning of Spring 2006 Semester</td>
<td></td>
</tr>
<tr>
<td>2/14</td>
<td>First proposal presentation</td>
<td></td>
</tr>
<tr>
<td>2/16</td>
<td>First proposal presentation</td>
<td></td>
</tr>
<tr>
<td>3/4</td>
<td>IRB approval</td>
<td></td>
</tr>
<tr>
<td>3/19</td>
<td></td>
<td>Progress report presentation</td>
</tr>
<tr>
<td>3/30</td>
<td>Initial interview (Dr. K)</td>
<td>Progress report presentation</td>
</tr>
<tr>
<td>4/4</td>
<td>IRB modification approved</td>
<td></td>
</tr>
<tr>
<td>4/6</td>
<td>Classroom observations</td>
<td></td>
</tr>
<tr>
<td>4/6</td>
<td>On-campus focus group</td>
<td></td>
</tr>
<tr>
<td>4/11</td>
<td>Classroom observations</td>
<td></td>
</tr>
<tr>
<td>4/13</td>
<td>Classroom observations</td>
<td></td>
</tr>
<tr>
<td>4/18</td>
<td>Course quiz</td>
<td></td>
</tr>
<tr>
<td>4/20</td>
<td>Final oral presentations</td>
<td></td>
</tr>
<tr>
<td>4/25</td>
<td>Final interview (Dr. K)</td>
<td>Final oral presentations</td>
</tr>
<tr>
<td>4/27</td>
<td></td>
<td>Final oral presentations</td>
</tr>
<tr>
<td>5/4</td>
<td>Off-campus interview</td>
<td></td>
</tr>
<tr>
<td>5/5</td>
<td></td>
<td>End of Spring 2006 Semester</td>
</tr>
<tr>
<td>5/21</td>
<td>Member checking email sent (faculty and student participants)</td>
<td></td>
</tr>
<tr>
<td>5/25</td>
<td>Dr. K responds: Transcription okay; no response from students</td>
<td></td>
</tr>
<tr>
<td>5/26</td>
<td>Deadline for member checking</td>
<td></td>
</tr>
<tr>
<td>9/1</td>
<td>Interview with Dr. K: Technology in the classroom</td>
<td></td>
</tr>
<tr>
<td>9/17</td>
<td>Member checking email sent (Dr. K)</td>
<td></td>
</tr>
<tr>
<td>9/22</td>
<td>Deadline for member checking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dr. K responds: Transcription okay</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.2. Data Collection Methods, Sources, and Instruments for the First Case Study

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-structured Interview</td>
<td>1 engineering faculty 60 min each (2 interviews): 1 follow-up session</td>
<td>Interview protocol</td>
</tr>
<tr>
<td>EBI&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1 engineering faculty 10 min (1 EBI)</td>
<td>EBI</td>
</tr>
<tr>
<td>Focus group</td>
<td>2 engineering students 30 min (1 focus group)</td>
<td>Interview protocol</td>
</tr>
<tr>
<td>Semi-structured interview</td>
<td>1 DE&lt;sup&gt;b&lt;/sup&gt; student 10 min (1 phone interview)</td>
<td>Interview protocol</td>
</tr>
<tr>
<td>Observation</td>
<td>3 real-time lectures 4½ hours (3, 1½ hr. classroom observations)</td>
<td>Observation Pro Forma</td>
</tr>
<tr>
<td>Observation</td>
<td>3 archived lectures (for DE students) 4½ hours (3, 1½ hr. classroom observations via ftp server)</td>
<td>Observation Pro Forma</td>
</tr>
<tr>
<td>Document analysis</td>
<td>Course materials in WebCT N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Field notes/ Researcher journal</td>
<td>Researcher 3 mos</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<sup>a</sup>Epistemological Beliefs Inventory. <sup>b</sup>Distance education

**Semi-Structured Interview and the EBI**

The semi-structured interview was designed to probe Dr. K’s beliefs about his teaching and classroom practices using technology. The interview questions (see Appendix A) were adopted and modified from Martin et al.’s (2000) interview summary:

Object of study:

How students are brought into relation with the objects of study

Approach to teaching:

Approach to learning:

Desired learning outcomes. (p. 392)
I modified the interview summary into semi-structured interview questions in order to meet the objectives for this study (to identify how engineering faculty members’ professed beliefs are similar to or different than their observed instructional practice using technology). The semi-structured interview questions are described below.

*What is the main objective of your course? Do you have any other objectives for your course? If yes, what are they?*

The interview began by asking the professor what his main course objectives were for his course. It was important to understand the professor’s main course objectives in order to understand what it was that the professor was to teach during the course and to identify the professor’s reason for teaching the students the course materials.

*How are students brought into active connections with the main objective for the course? How are students brought into relations with other objectives for your course?*

The second aspect of the interview focused on Dr. K’s espoused teaching beliefs about students’ active connections with course objectives. It was important to understand the professor’s beliefs about his students’ involvement in the course in order to identify ways in which the professor believed his students’ actively learn the course materials and thus to identify any real world, authentic activities led by Dr. K that would connect the students with realistic job activities.

*What are your approaches to teaching?*

The third aspect of the interview focused on identifying Dr. K’s espoused beliefs about his approaches to teaching. It was important to understand the professor’s approaches to teaching in order to compare his espoused teaching beliefs with his actual classroom
practice, which in turn would allow me to communicate with Dr. K about his approaches to teaching.

*What are your approaches to learning?*

The fourth aspect of the interview focused on identifying Dr. K’s espoused beliefs about his approaches to learning. It was important to understand the professor’s approaches to learning so that I could speculate on how Dr. K wanted his students to learn.

*What are the desired learning outcomes of your course?*

The fifth aspect of the interview focused on identifying Dr. K’s desired learning outcomes of his course. It was important to understand what the professor expected the students to take away from his course so that I could speculate whether or not the course objectives guided the professor to meet the desired learning outcomes of his course.

After the observations were completed, I met with Dr. K and administered the EBI (see Appendix F). The EBI was completed by Dr. K before the final interview using standard protocol and lasted approximately 10 minutes. The final interview covered the same semi-structured interview protocol that was used during the first interview (see Appendix A).

After the data were collected, I analyzed the data. I noticed the lack of technology-related responses after analyzing the transcribed data, therefore a follow-up session was arranged with Dr. K to clarify his espoused beliefs about teaching with technology.
Focus Group and Off-Campus Student Interview

Dr. K’s course enrolled 12 students. Eight of the 12 students were on-campus students and were present during 100% of the course observations. Two of his on-campus students volunteered to be in a focus group, and one of his off-campus students volunteered to participate in an interview over the phone (please see below). Permission was obtained from the instructor of the course before asking his students for their participation.

The two on-campus students were interviewed for 30 minutes, using semi-structured interview questions (see Appendix B), to address their perceptions of course instruction. After the two students were interviewed, I continued to observe Dr. K’s teaching.

During the classroom observation period, I contacted one off-campus student via email to participate in a phone interview (see Appendix C). The off-campus student agreed to participate and a phone interview time was established. I telephoned the off-campus student, read through the informed consent, and received verbal agreement from that student to participate in the first case study, and this phone interview lasted approximately 20 minutes.

Observations

After Dr. K was interviewed, his classroom was observed. An observation checklist (observation pro forma, as defined by Martin et al., 2000) was used to document each observation (Appendix D). The observation pro forma for this first case study was adopted from Martin et al.’s (2000) observation pro forma:
Strategy for observation session

Lecturer’s intentions:

Hypothesis:

Teacher/student interaction

Things to watch for in the observation (p. 392)

Martin et al.’s observation pro forma was then modified to meet the objectives for this study:

- Lecturer’s intentions:

- Objectives:
  - Teacher/student interaction:
  - Variety of techniques (describe):
  - Teacher talk vs. student talk:

Archived lectures also were used to observe the lectures after the course ended. The items addressed before the second case study are outlined below.

Items Addressed Before the Second Case Study

The original questions from the first case study were used successfully. However, the lack of technology-specific interview questions led to very little description of the use of technology in the classroom by both faculty and students. As a response to the lack of technology-related answers collected from the first case study, I developed additional technology-specific questions (see Appendix G) that were included in the semi-structured interview questionnaire for the second case study (see further details in Chapter 5).
The research approaches and methods of analysis were used successfully. The vignette was successfully compared to Martin et al.’s (2000) vignette, “Dr. Leon” (p. 403). These findings enabled me to explain the phenomenon, although a more in-depth analysis using a contrasting case study would be useful in explaining the phenomenon in more detail. Therefore, a second contrasting case study was examined for the second case study.

The Second Case Study

The aim of the second case study was to explore in more detail a different engineering faculty member’s espoused beliefs, his observed classroom practices in a technology-equipped classroom, and his students’ perceptions of his classroom practices.

Data Collection Methods and Participants

During the Fall 2006 semester, I selected from a list of faculty members provided by the College of Engineering one contrasting faculty member who utilized a wide variety of technology in his course as a means for enabling his on- and off-campus students to clearly understand the course materials. I identified Dr. J as being a typical engineering faculty member who was willing to participate in a research investigation about espoused beliefs and classroom practices in a technology equipped classroom. Dr. J used a wide variety of technologies in the classroom and was very familiar with the EDE unit; he had worked with the unit since 1998 and had taught 26 courses, 9 of which were pre-recorded courses, through EDE. The research started in October 2006 (please see the timeline in Table 3.3), and the data collection methods and allocation of participants are outlined in Table 3.4.
Table 3.3. Timeline for the Second Case Study Research with Key Events for the Course and Research

<table>
<thead>
<tr>
<th>Date (2006)</th>
<th>Research key events</th>
<th>Course key events</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/21</td>
<td></td>
<td>Beginning of Fall 2006 Semester</td>
</tr>
<tr>
<td>8/31</td>
<td>IRB Approved</td>
<td>Off-campus students submit a biography with picture</td>
</tr>
<tr>
<td>9/1</td>
<td></td>
<td>Paper proposal due; Requirements Development assignments due; Evaluation of Requirements assignments due; Exam 1 due</td>
</tr>
<tr>
<td>9/1-10/6</td>
<td>Paper proposal due; Requirements Development assignments due; Evaluation of Requirements assignments due; Exam 1 due</td>
<td></td>
</tr>
<tr>
<td>10/27</td>
<td>Initial interview (Dr. J)</td>
<td>All Analytical Hierarchy Process assignments to be submitted</td>
</tr>
<tr>
<td>11/01</td>
<td></td>
<td>All Decisions under Risk and Uncertainty Assignments to be submitted</td>
</tr>
<tr>
<td>11/7-11/9</td>
<td>Classroom observations</td>
<td></td>
</tr>
<tr>
<td>11/10</td>
<td>Off-campus interview (1)</td>
<td>Exam 2 to be submitted by all students</td>
</tr>
<tr>
<td>11/13</td>
<td>Off-campus interview (1)</td>
<td>All engineering economy assignments to be submitted</td>
</tr>
<tr>
<td>11/14</td>
<td>Classroom observations</td>
<td></td>
</tr>
<tr>
<td>11/14-11/15</td>
<td>Off-campus interviews (3); On-campus interview (1)</td>
<td></td>
</tr>
<tr>
<td>11/16</td>
<td>Classroom observations</td>
<td></td>
</tr>
<tr>
<td>11/27</td>
<td></td>
<td>All students submit research paper</td>
</tr>
<tr>
<td>11/28</td>
<td>Classroom observations</td>
<td></td>
</tr>
<tr>
<td>11/30</td>
<td>Classroom observations; On-campus interview (1)</td>
<td></td>
</tr>
<tr>
<td>12/5</td>
<td>Classroom observations</td>
<td></td>
</tr>
<tr>
<td>12/6</td>
<td></td>
<td>All Monte Carlo Simulation assignments to be submitted</td>
</tr>
<tr>
<td>12/7</td>
<td>Classroom observations</td>
<td></td>
</tr>
<tr>
<td>12/13</td>
<td></td>
<td>All Final Exams to be submitted</td>
</tr>
<tr>
<td>12/14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12/15</td>
<td></td>
<td>End of Fall 2006 Semester</td>
</tr>
<tr>
<td>1/9</td>
<td>Member checking email sent (faculty and student participants); One on-campus student responded with clarifications for one of her answers</td>
<td></td>
</tr>
<tr>
<td>1/10</td>
<td>Dr. J responded that both transcripts were okay</td>
<td></td>
</tr>
<tr>
<td>1/16</td>
<td>Deadline for member checking</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.4. Data Collection Methods, Sources, and Instruments for the Second Case Study

<table>
<thead>
<tr>
<th>Method</th>
<th>Source</th>
<th>Description</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-structured Interview</td>
<td>1 engineering faculty</td>
<td>60 min each (2 interviews)</td>
<td>Interview Questionnaire</td>
</tr>
<tr>
<td>EBI^a</td>
<td>1 engineering faculty</td>
<td>10 min (1 EBI)</td>
<td>EBI</td>
</tr>
<tr>
<td>Semi-structured interview</td>
<td>2 engineering students</td>
<td>20-30 min (two individual interviews)</td>
<td>Interview Questionnaire</td>
</tr>
<tr>
<td>Semi-structured interview</td>
<td>5 DE^b student</td>
<td>10-15 min (1 phone interview)</td>
<td>Interview Questionnaire</td>
</tr>
<tr>
<td>Observation</td>
<td>8 real-time lectures</td>
<td>12 hours (8, 1½ hr. classroom observations)</td>
<td>Observation Pro Forma</td>
</tr>
<tr>
<td>Observation</td>
<td>28 archived lectures (for DE students)</td>
<td>32 hours (28, 1½ hr. classroom observations via ftp server)</td>
<td>Observation Pro Forma</td>
</tr>
<tr>
<td>Document analysis</td>
<td>Course materials in WebCT</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Field notes/ Researcher journal</td>
<td>Researcher</td>
<td>2 mos</td>
<td>N/A</td>
</tr>
</tbody>
</table>

^aEpistemological Beliefs Inventory. ^bDistance education

**Semi-Structured Interview and the EBI**

The semi-structured interview was designed to probe Dr. J’s beliefs about his teaching and classrooms practices using technology. The original semi-structured interview questions were adapted and modified to include technology-specific questions (see Appendix G for the adapted and modified semi-structured interview) for the second case study. The technology-specific questions are outlined below.

*How are technologies used to meet the main objectives of your course?*

The first technology-specific question in the semi-structured interview addressed how technologies were used in the course to help the professor meet the main objectives of
his course. It was important to know this so that I could identify the technologies that the professor used the most to meet the main objectives of the course.

*What technologies do you use in connection with your course (e.g. WebCT [streaming lectures, discussion board, university email], telephone, etc.)? Prompt the instructor to discuss various technologies used in the course. For each technology addressed, ask what the intended purpose is from their perspective.*

The second technology-specific question focused on identifying technologies that Dr. J used in connection with his course. It was important to understand what technologies the professor used to actively connect with his course (e.g., the materials and the students) in order to be able to describe each of the technologies that were used and their intended purpose.

*What technologies will be used again?*

After Dr. J addressed the technologies that he used in his course, I asked him what technologies he would use again (the third technology-specific question). It was important to identify these technologies in order to understand what technologies were successful in delivering his course.

*How do you use technologies to enhance your approaches to teaching?*

The fourth technology-specific question addressed how Dr. J used technologies in his course to enhance his approaches to teaching. It was important to understand how the professor used technologies to enhance his approaches to teaching in order to support why he used the technologies in the classroom.
How do you use technologies to enhance your approaches to learning?

The fifth technology-specific question focused on identifying how Dr. J used technologies in his course to enhance his approaches to learning. It was important to understand how the professor used technologies to enhance his approaches to learning in order to support why he used the technologies throughout his learning.

How do you use technologies to achieve the desired learning outcomes of your course?

The sixth and final technology-specific question addressed how Dr. J used technologies in his course to achieve the desired learning outcomes of his course. It was important to understand how the professor used technologies to achieve these desired learning outcomes in order to support why he used the technologies in his course delivery.

After the observations were completed, I met with Dr. J and gave him the EBI (see Appendix F) to complete. He completed the inventory and handed it to me at a later date. The final interview covered the same semi-structured interview questionnaire that was used during the first interview (please see above).

On-Campus Student Interviews and Off-Campus Student Phone Interviews

Dr. J’s course enrolled 75 students. Eleven of the 75 students were on-campus students and all were present during 95% of the course observations. No on-campus students volunteered to be part of a focus group, therefore I decided to ask if students preferred to be interviewed individually. Two of his on-campus students volunteered to be interviewed individually after class. Five off-campus students volunteered to participate in
an interview over the phone. Permission was obtained from the instructor of the course before asking his students for their participation.

The two on-campus students were interviewed individually for 15 minutes, using the semi-structured interview questions (see Appendix H), to address their perceptions of the course. During the same period as the on-campus interviews and Dr. J’s classroom observations, I contacted the off-campus students via email to recruit volunteers to participate in the second case study. Five off-campus students responded to the email and agreed to participate in the study. A few of the off-campus students missed or changed their meeting times, however all five students were interviewed. I read through the informed consent and received verbal agreement from each of them to participate in the interview. The off-campus phone interviews (see Appendix I) lasted between 5 and approximately 14 minutes for each student.

**Observations**

After Dr. J was interviewed, I observed his classroom for a total of 12 hours: eight class observation sessions that were each 1.5 hours long. An observation checklist (observation pro forma; see Appendix D) was used to document each observation along with my journal that was used to take notes during the observation sessions. The observation pro forma for this second case study was adopted and modified from Martin et al.’s (2000) observation pro forma (see the first case study methods). I was able to access archived lectures, as an EDE Staff member, after the classroom observations were completed. The methods for analysis are outlined below.
Methods for Analysis of the Two Case Studies

I organized the transcribed interviews from faculty and students and the classroom observations (by lecture) using Martin et al.’s (2000) observation pro forma. I also organized each of the two case study’s course materials into one folder for easy access (e.g., three streaming lectures, lecture notes, syllabus), plus the analysis of the EBI. Data, with the exception of the EBI, were analyzed using qualitative methods (e.g., coding and organizing the data). The five stages of analysis are now presented in this order: EBI; Course Objectives; Approaches to Teaching; Course Objectives, Approaches to Teaching, and Teaching with Technology; and Phenomena of Dr. K’s and Dr. J’s Teaching with Technology.

Stage 1: EBI

The EBI (Appendix J) was developed to measure all five hypothesized beliefs and is shorter and more reliable than any other instrument that examines epistemic beliefs (Schraw et al., 2002). Schraw et al. created the 32-item inventory with a five-point Likert-type scale, 1 being *strongly disagree* and 5 being *strongly agree*. The five hypothesized beliefs that the EBI measures pertain to adults’ beliefs about simple knowledge, certain knowledge, omniscient authority, quick learning, and innate ability. These categories correspond to Schommer’s (1990) Epistemological Questionnaire (EQ) but has better “predictive validity than the EQ when correlated with a test of reading comprehension and the EBI [has] considerably better test-retest reliability than the EQ” (Schraw et al., p. 271).
The EBI is considered more reliable over time, because it “[yields] a close replication of factors between the initial and replication analyses, while the EQ [does] not” (p. 272).

When analyzing the two faculty members’ EBI results I used the same categories (codes) as Schraw et al. (2002) outlined in Table 3.5 (and described in detail in Chapter 2). I coded the survey instrument and as there was only one engineering faculty participant for each of the case studies descriptive statistics were used to understand where the two faculty members fit in the frequency distributions of the five dimensions. This enabled me to also verify the fit of their interview answers with the EBI categories. The results were used to help describe Dr. K’s and Dr. J’s espoused beliefs in Chapter 4 and Chapter 5, respectively.

**Stage 2: Course Objectives**

The inclusive hierarchies used to analyze this research investigation were the same as Martin et al.’s (2000) resulting categories of description. Martin et al. developed these categories, which are in common with most phenomenographic analyses, from their research investigation in which 26 university teachers were interviewed and their classrooms observed to identify the discrepancies between the teachers’ intended approaches to teaching and their observed classroom practices using technology.

I used these categories to describe the variation in terms of what Dr. K (Chapter 4) and Dr. J (Chapter 5) each intended to teach his students (course objectives) and how each intended to bring students into active connections with the course objectives. These two faculty members’ initial and final interviews, as well as the students’ interviews (focus group, interview questionnaires, and off-campus student phone interviews) and course materials, were analyzed using these categories in order to classify the faculty members’
Table 3.5. Schraw et al.’s (2002) Hypothesized Beliefs used for the EBI (L. Bendixen, personal communication, April 1, 2006)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SK</td>
<td>Simple Knowledge</td>
</tr>
<tr>
<td>CK</td>
<td>Certain Knowledge</td>
</tr>
<tr>
<td>OA</td>
<td>Omniscient Authority</td>
</tr>
<tr>
<td>QL</td>
<td>Quick Learning</td>
</tr>
<tr>
<td>FA</td>
<td>Fixed Ability</td>
</tr>
</tbody>
</table>

course objectives. I systematically triangulated the data in order to identify the main course objectives. These course objectives were then compared to Martin et al.’s (2000) categories, which are also the categories for this research investigation. The categories are outlined below. The [course objective] is:

A. The subject matter of the topic as it is represented in the external world. The focus is on that part of the curriculum assigned to that teacher; the teacher will present this topic to the students.

B. The subject matter of the subject as a whole as it is represented in the external world. The teacher describes what is to be taught in the context of the subject. The teacher will present the topic and draw links between this and other parts of the subject.

C. Student understanding of the subject matter in relation to the discipline as a whole. The teacher introduces a body of knowledge and the ways in which this knowledge has been developed is explored and applied.
D. Student understanding of the subject matter in relation to professional practice.

The teacher engages the student with the elements of professional practice.

E. Student development of lifelong analytical skills through the study of the subject matter. The teacher develops a practice of critical thinking, inquiry, and reflection. (p. 393)

The categories are expressed from lower level to higher level categories (Category A to Category E) in relation to the cognitive levels of development as expressed by Jean Piaget, Lev Vygotsky, and Benjamin Bloom (e.g., Bloom’s Taxonomy). Categories A and B represent a less problematic and multi-structural definition of the object of study and refer to knowledge as it exists in an external world (e.g., knowledge as it is expressed in textbooks (Martin et al., p. 393). Categories C, D, and E represent a more complex and relational definition of the object of study and refer to knowledge as it is developed within people (e.g., knowledge as it is established within the students; Martin et al., p. 393). The relationship between these categories of descriptions is summarized in Table 3.6.

Stage 3: Approaches to Teaching

I then analyzed Dr. K’s and Dr. J’s approaches to teaching using the “variations in approaches [to teaching] in terms of the teachers’ intentions and strategies” (p. 394) developed by Martin et al. (2000). The two faculty members’ initial and final interviews, students’ interviews (focus group, interview questionnaires, and off-campus student phone interviews), course materials, and classroom observations were analyzed using Martin et al.’s categories in order to classify the faculty members’ approaches to teaching. I
Table 3.6. Categories of Description for the Object of Study used in this Study (Martin et al., 2000, p. 394)

<table>
<thead>
<tr>
<th>Structural</th>
<th>Referential</th>
<th>Knowledge exists in external world</th>
<th>Knowledge exists in people</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multistructural</td>
<td>Topic</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subject</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Relational</td>
<td>Discipline</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Practice</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lifelong Learning</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

systematically triangulated the data in order to identify the faculty members’ approaches to teaching. These teaching approaches were then compared to Martin et al.’s categories (outlined below), which were initially drawn from the categories of descriptions for approaches to learning by Trigwell, Prosser & Taylor (1994):

A. The teacher presents materials to be learned with the intention of transferring information to students, the teacher believes that there is a body of knowledge to be presented to students, and the teacher presents the information to students.

B. The teacher covers the material to be learned with the intention of transferring information to students, the teacher is mindful of the parameters of the content to be learned and seeks to ensure that all the material designated in the
curriculum is covered, and that the material is presented to the students during the time specified for each class.

C. The teacher seeks to clarify and explain the material to be learned, according to the curriculum, with the intention that the correct information has been transferred.

D. The teacher engages students with discipline knowledge with the intention of helping students develop their conceptual understanding. The teacher’s intention is to enable students to learn the material through demonstrations of the principles to be learned and through the use of examples related to the student’s own experiences.

E. The teacher engages students in the practice of the discipline with the intention of helping students develop their conceptual understanding. The teacher’s intention is to enable the student to learn the material through practicing the discipline knowledge by engaging students with the material in ways similar to that of the qualified practitioner.

F. The teacher engages the students in challenging their discipline understanding and/or professional practice with the intention of helping students to change their conceptual understanding. The teacher’s intention is to change the student’s conceptions of the practice of the profession through challenging existing conceptions. (p. 394-395)
All of the categories above describe an approach to teaching espoused by the 26 teachers interviewed by Martin et al. The relationship between these categories of descriptions is summarized in Table 3.7.

The findings from Martin et al. (2000) identified that “13 teachers whose object of study was classified as either A or B had their approaches to teaching classified as either A, B, or C” (p. 397-398). Martin et al. found that the other “13 teachers whose object of study was classified as either C, D, or E had approaches to teaching classified as either D, E or F” (p. 398).

Stage 4: Course Objectives, Approaches to Teaching, and Teaching with Technology

After the two faculty members’ course objectives and their approaches to teaching were analyzed and categorized, I exemplified, through a vignette, the ways that Dr. K (Chapter 4) and Dr. J (Chapter 5) described their teaching beliefs and the relationship between their espoused teaching beliefs and their approaches to teaching using technology. Dr. K’s initial, final, and technology interviews and Dr. J’s initial and final interview; their students’ interviews (focus group, interview questionnaires, and off-campus student interviews); their course materials; and their classroom observations were analyzed using Martin et al.’s (2000) categories. I systematically triangulated the data in order to identify the relationship between each faculty member’s espoused beliefs and his approaches to teaching with technology. Martin et al.’s categories (adapted and modified to fit this research investigation) were: What is it that you teach to your students?; What must your students know?; How will your students be brought into active connections with that knowledge?; teacher’s observed practice; teacher’s approaches to teaching with
Table 3.7. Categories of Description for Approaches to Teaching used in this Study (Martin et al., 2000, p. 396)

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Intention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Information transmission</td>
</tr>
<tr>
<td>Teacher focus</td>
<td>Conceptual development</td>
</tr>
<tr>
<td>Presenting material</td>
<td>Conceptual change</td>
</tr>
<tr>
<td>Covering material</td>
<td>A</td>
</tr>
<tr>
<td>Clarifying material</td>
<td>B</td>
</tr>
<tr>
<td>Student focus</td>
<td>C</td>
</tr>
<tr>
<td>Engaging with discipline knowledge</td>
<td>D</td>
</tr>
<tr>
<td>Practicing discipline knowledge</td>
<td>E</td>
</tr>
<tr>
<td>Challenging discipline understanding/ professional practice</td>
<td>F</td>
</tr>
</tbody>
</table>

technology; and teacher’s reflection on practice (p. 398-400). The vignette for Dr. K is provided in Chapter 4; the vignette for Dr. J is provided in Chapter 5.

Stage 5: Phenomena of Dr. K’s and Dr. J’s Teaching with Technology

In the fifth and final stage for the first case study, I compared the findings from Stages 2 through 4 to identify possible disconnects between Dr. K’s espoused beliefs and his classroom practices using technology. In comparing the findings from Stages 2 through 4 for the first case study, I identified a lack of technology-specific interview answers from Dr. K or his students. In response to the lack of technology-related answers, I developed technology-specific questions (discussed earlier). The findings from Stages 2 through 4, including the additional technology findings, enabled me to describe, in Chapter 4, how Dr.
K’s professed beliefs were similar to or different than his observed instructional practice using technology. In comparing the findings from Stages 2 through 4 for the second case study I was able to describe how Dr. J’s professed beliefs were similar to or different than his observed instructional practice using technology (Chapter 5). These similarities and/or differences were expressed in response to the research investigation question: How do an engineering faculty member’s espoused beliefs relate to his/her observed classroom practices using technology?

Ethical Considerations

The case studies were researched during the Spring 2006 and Fall 2006 semesters within a context that I, a pre-doctoral associate for the EDE unit, was employed; therefore ethical issues were addressed. Particular care was taken to reduce risks to the faculty, staff, and student participants:

- The research was voluntary and all participants had the ability to withdraw at any time.
- Permission was obtained from the Associate Dean (the supervisor of the EDE unit) before conducting any research on the EDE faculty and students.
- Permission was obtained from both engineering faculty members to research their students during their ongoing courses.
- There was time to establish a relationship of trust between both professors and myself.
- There was a debriefing on long-term support with both professors after the case studies were completed.
As a participant researcher it was also necessary to address the biases that occurred during the research study. I:

- Listened to and observed both professors without identifying specific instances that could have been approached differently.
- Explained terms widely used in education to both professors to eliminate any misunderstanding and/or miscommunication.
- Repeated answers given by the professors back to the professors to ensure correct understanding of the course content.

And as a doctoral candidate specializing in Curriculum and Instructional Technology at this university, I identified my own biases for this research investigation. I:

- Influenced both professors’ practice, in that each professor is more aware of how his students learn and how he wants to connect with students actively with the course content to improve student learning.
- Did not instruct either professor to approach their teaching in a different way during the study.
- Did not judge either professor’s approaches to teaching; I questioned both professors’ approaches in order to understand, fundamentally, why and how they came to be the professor they were.

All participation in this study was completely voluntary, however no one withdrew.
CHAPTER IV
THE FIRST CASE STUDY: DR. K

Introduction

This chapter provides a case study of one engineering faculty member’s espoused beliefs and classroom practices using technology. The findings begin by introducing the background of Dr. K (pseudonym), the faculty member for the first case study, followed by his espoused beliefs. The descriptions of Dr. K’s teaching, including the use of technology are then presented, followed by his course description. Next, the analysis of this first case study contrasts Dr. K’s beliefs with his teaching. The phenomenon of Dr. K’s espoused beliefs and classroom practices using technology is then presented, followed by an exemplary vignette of Dr. K’s teaching that is compared with the findings from Martin et al. (2000). The findings end with a summary of this case study. The chapter concludes with proposed improvements for research for a second case study, which is presented in Chapter 5.

The Engineering Faculty Member, Dr. K

During the first interview, I was able to identify Dr. K’s background experiences that led him to become a professor in the College of Engineering at this midwestern university. Dr. K completed his undergraduate degree in his home country and then moved to the United States and pursued graduate studies. During this time he was employed as a teaching assistant and he “did not have any formal preparation for it, but it was like you know whatever—through experience” (Dr. K Interview 1, 3/30/06). When he completed
his Ph.D., he worked for two years with the world’s largest automaker. By understanding the fundamentals of the engineering design process, Dr. K was able to apply his knowledge to existing and new materials in order to develop effective design processes. Dr. K stated during the interview that he was paired up with a very experienced automobile dye designer who “was working there maybe 25–30 years” with mild steel and who could “smell” what they needed to add or remove from the design in order to remove defects (Dr. K Interview 1, 3/30/06). Dr. K stated how he would run computer codes for days in order to come up with the same findings that the experienced worker could smell. Then, aluminum killed steel replaced mild steel and “one day [he] found out that [the experienced worker] was looking for [him] because all of his experience with this mild steel does not work with aluminum killed steel; it has better rust characteristics, it was different materials—it is a different beast” (Dr. K Interview 1, 3/30/06). When the experienced worker questioned Dr. K, Dr. K was able to explain:

The material does this and does this and this is how it is different from mild steel and it has different types of properties like sling back and [the experienced worker] latched on to it immediately and then immediately, like after a few times [the experienced worker] was able to do the same things as before and he would look at it and be like—yes do that. So what [the experienced worker] did he took this information about the new material and the new materials properties and he assimilated it into his concept map of the process. (Dr. K Interview 1, 3/30/06)
Drawing on this experience, he explained that you have to be careful in industry, because “you can have 20 years of experience, but you have to ask is that 20 years, or is that one year repeated 20 times” (Dr. K Interview 1, 3/30/06).

Dr. K described during his initial interview, how he had learned to approach teaching from educators he had when he was in [his native country] and during his graduate studies in the United States:

   Dr. K: If I see that they don’t understand then I try to approach it from a different angle or next class trying a slightly different approach or sometimes they need different background material. If I can identify what that background material is that they are lacking then I can tell them to go read that or go look at that.

L: That’s great, and do you feel that way because of your own experiences in [your home country] or do you feel that it is you know, it is hard to have that compassion and care. . . .

   Dr. K: When I grew up as a student, I was taught that way and that kind of engraved in my brain . . . not only in [my home country] but in this country when I took graduate studies it was the same way, so I think that interaction is necessary. (Dr. K Interview 1, 3/30/06)

After Dr. K worked in the workforce for two years, he came back to this midwestern university as a professor without any formal experience.

   Dr. K, as a professor in the College of Engineering, taught a majority of his graduate courses through EDE, an option available to all College of Engineering professors. I had met and worked with Dr. K during the Fall 2005 semester and had already
established a positive, working relationship with him. Therefore, I had identified early on, from prior conversations and course facilitation meetings, that he was intrigued with the use of technology in his classrooms and believed that he could reach many students all over the world with his teaching. In order to understand Dr. K’s espoused beliefs in more detail, I prepared and employed a semi-structured interview (please see Chapter 3 for further details) to identify Dr. K’s espoused beliefs; the results are outlined below.

Dr. K’s Espoused Beliefs

Dr. K was interviewed before and after the classroom observations in order to understand his espoused beliefs and compare his espoused beliefs from the initial interview with the final interview in order to identify similarities, growth, and/or reflection. Dr. K completed the EBI before completing the second interview. The EBI results and the semi-structured interview questions outlined in Chapter 3 are also used to present these beliefs in this order: EBI results, Course Objectives, Students’ Active Connections with Course Objectives, Approaches to Teaching, Approaches to Learning, and Desired Learning Outcomes of the Course.

EBI Results

From the EBI results (please see Table 4.1) I identified that Dr. K appeared to have a range of epistemic beliefs. Dr. K believed that knowledge is complex (Simple Knowledge), it is neither handed down by authority nor derived from reason (Omniscient Authority), and it is tentative (Certain Knowledge). Dr. K also believed that the ability to learn is acquired (Fixed Ability) and that learning is not quick at all (Quick Learning). The
Table 4.1. The Mean Score for each EBI Category for Dr. K

<table>
<thead>
<tr>
<th>EBI category</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omniscient authority</td>
<td>2.80</td>
</tr>
<tr>
<td>Simple knowledge</td>
<td>2.42</td>
</tr>
<tr>
<td>Quick learning</td>
<td>2.40</td>
</tr>
<tr>
<td>Certain knowledge</td>
<td>2.38</td>
</tr>
<tr>
<td>Fixed ability</td>
<td>2.14</td>
</tr>
</tbody>
</table>

Interview data supported Dr. K’s epistemic beliefs. From my perspective, these beliefs fit best in the cognitive realm of knowledge accumulation and synthesis. For example, Dr. K said:

You not only have the information—you have to do something with it—you know, I mean just 25 years ago having the information was enough but today you have to do something with it—and to do something with the information—this is my personal view—I think that you have to have a concept map of how this information fits into the bigger picture—how I can use it in a bigger scheme of things. (Dr. K Interview 1, 3/20/06)

From this, I began to understand that Dr. K believes that his students should be able to learn the information in a way that is meaningful for them to understand in multiple content areas and in multiple contexts. He indicated throughout the interviews that he wanted his students to be able to apply their knowledge to real world activities; for example:
At first you have to accumulate the knowledge and then you have to analyze it and then you try to synthesize with it and in a undergraduate class it is probably more knowledge accumulation and if I can get them to analyze some synthesis that would be fantastic . . . and in a graduate class you can take them to synthesis because synthesis is where today’s economy and globalization is where the value is—an employer values your skills if you can synthesize, so those are the skills that we should shoot for . . . (Dr. K Interview 1, 3/30/06)

Dr. K’s espoused beliefs identified above were consistent with the results from the interview questions as described below.

**Course Objectives**

Dr. K’s espoused course objectives identified consistently in both interviews were “to get the students to understand these mechanics so that they are able to analyze the machining processes into these different facets and then they are able to understand it and utilize it in hopefully designing a manufacturing process” (Dr. K Interview 1, 3/30/06) and “to make the students understand what are the fundamental issues in machine processes and how they can make the processes more effective and more efficient and to put these things together to design processes” (Dr. K Interview 2, 4/25/06). Dr. K stated also that “one [course] objective would be [to] help [the students] in thinking [about] how to design better manufacturing processes and connect it with thinking about manufacturing in general” (Dr. K Interview 2, 4/25/06).

From my perspective, all of the espoused course objectives helped guide Dr. K through his course teachings and the course assignments, which were: a semester-long,
phased paper; one take home quiz; and three presentations (please also see Table 3.1 for the Course Key Events). There were no objectives pertaining to technology or the use of technology.

Students’ Active Connections with Course Objectives

Dr. K’s espoused teachings identified were: comparing and contrasting various theories of design and design processes, giving students feedback throughout their activities, and moderating student activities. The descriptions of the students’ active connections with the course objectives were consistent between interviews. Dr. K described the flow of his course in the first interview as follows:

The way I do it is first I cover some basics of the manufacturing process so they understand the fundamental aspects and then I cover from some research papers and that is like the intermediate step and then you will see that in the next couple of lectures that I will start talking about some design aspects, so that is kind of the flow of the course. (Dr. K Interview 1, 3/30/06)

In the second interview he stated:

The way the course is supposed to work is that I discuss different articles and these articles discuss manufacturing and machining from different points of views, so in my presentation I try to compare and contrast them—like this is a theory and it has its assumptions and either it has strengths and weaknesses and the idea is that the students in their presentation—they are supposed to tell me what they thought of it and what they thought out of reading these four or five different articles—the students let me know what the theory should be . . . they choose a topic . . . and then
associate it with the topic of similar articles. . . . And, then also they can go a step beyond and say—okay if these are the facts then how can you design a process that is based on those. . . . Then I give them some feedback, like no this is a PhD thesis you cannot do that or no this is only like one week’s work I need to ask you to do more. . . . This is just strategy wise—the approach is that I am very tough on them at the proposal stage and I get a little more lenient in the progress stage, and then in the final—you know because at that point they have already done it—you know. . . . I also try to moderate it a bit. (Dr. K Interview 2, 4/25/06)

Dr. K also stated that he discussed different articles with his students because he wanted his students to develop their own understanding of the theories within certain contexts. He explained that students appeared to understand their chosen theories more as they progressed through the course.

Dr. K affirmed that “sometimes [he] invite[s] guest lectures and that gives [the students] another perspective” (Dr. K Interview 1, 3/30/06). This suggests that he believes that multiple perspectives can be crucial in helping students develop their own understanding about machining processes.

During the follow-up interview, Dr. K described the technologies that he used in his courses to connect students with the course content. He espoused beliefs that technology has enhanced his ability to organize his course materials and present information to his students. He affirmed that:

…technology is important, such as the design of the class, keeping it on pace, and presenting the materials, particularly figures; I mean PowerPoint helps you a lot
with figures, because if I try to draw those figures it would be a mess! (Follow-up interview, 9/1/06)

Dr. K expressed that he would use some of the technologies again in future courses because, he stated, they helped enhance his students’ learning. The technologies included WebCT, PowerPoint, the streaming lectures, and Dr. K stated that he would “try to use the discussion board, that would be good” (Follow-up interview, 9/1/06).

Approaches to Teaching

The descriptions of Dr. K’s approaches to teaching were consistent between interviews. He elaborated on some of his approaches to teaching (e.g., the flow of his course) during the second aspect of the interviews. He stated:

My approach is very simple, I think, the students ultimately their goal, or the goal of education is to empower you to innovate . . . I mean an innovation does not come out of thin air . . . a necessary step for innovation is understanding, so I think if you understand than maybe you would be able to innovate, but it does not guarantee that you can innovate. . . . So my major objective is to provide [my students] with that understanding so they can go on and say that they understand this and then they would be able to innovate from their own. . . . With 15 to 20 students that becomes quite manageable, but it is difficult to give 70 or 80 students attention. If they come [to my course] with a higher level of understanding then it may be doable, but if they come in at a lower level then it is a much tougher task. . . . If I see that they don’t understand then I try to approach it from a different angle or next class trying a slightly different approach or sometimes they need different background material.
If I can identify what that background material is that they are lacking then I can tell them to go read that or go look at that. (Dr. K Interview 1, 3/30/06)

From this conversation I was able to identify that Dr. K espoused beliefs about his students: He wants all of his students to be at a higher level of knowledge or understanding than when they arrived in the course. His ultimate goal (which I identified) was to help his students understand the material he is transmitting and that all the information one person says may not be correct compared to what another person says. For example, Dr. K stated:

You know, just because somebody says that this theory is true doesn’t mean that it’s like, what do you call, gospel, right. . . . You have to understand what are the assumptions, you know, underlying it . . . and it is only applicable if those assumptions are valid. . . . And so you understand the limitations of that—when you can use it and when you cannot use it . . . and once you do that you can do different things with that theory, right, then you can feel comfortable about applying it to a different class of problems because you believe—okay, this is a theory and it comes from—you know. . . but you know—his theory is applicable to this situation in the course context. (Dr. K Interview 2, 4/25/06)

The instructor espoused beliefs that people, in his opinion, must break down the pieces and dissect them in order to understand their applications, applications in different contexts, limitations, and assumptions. Dr. K explained that he learned that way so that is the way he believes he should teach his students. He believes that it is important to understand what students know, what they don’t know, and how to move students from one level of understanding to the next.
Dr. K also discussed concept-mapping software when describing his approaches to teaching. He believed that this software would scaffold his students’ learning until the students were able to design processes themselves (Researcher notes, 3/30/06). The concept mapping software was the only technological aspect discussed when describing his approaches to teaching.

Approaches to Learning

Dr. K’s espoused beliefs about his own approaches to learning were similar to his espoused approaches to learning for his students. The main difference was the metaphor used to describe his beliefs. He indicated that he breaks down the pieces into fundamental pieces and then puts them back together so that he understands how the pieces fit, are related, and work in different contexts. Dr. K stated that his approach to learning was the same one that he had as a child: “I would have a toy and then I would take it apart and then I would try to rebuild it, and I, uhh, demolished quite a few toys that way [laugh] . . . ” (Dr. K Interview 2, 4/25/06). He indicated that he became good at rebuilding toys because he began to understand how they worked from the inside out:

But you know then I got good at it and then I truly understood how those things worked . . . so it is like this—I have to kind of dissect it into pieces, into functional pieces and learn to understand what each piece does and then to understand how they are related to each other . . . and once you do that then you understand okay—also, it gives you a very good comparing thing—if you take let’s say—two or three different products that have the same functions, but maybe from two or three different companies . . . and do this you will realize how the different companies
design or manufactured them differently . . . and because they were designed and manufactured with different objectives . . . and you can gain a new perspective on how they are related. (Dr. K Interview 2, 4/25/06)

In the first interview, Dr. K discussed concept mapping and knowledge acquisition. He stated that the steps were quite natural in that:

…first you have to accumulate the knowledge and then you have to analyze it and then you try to synthesize with it and in an undergraduate class it is probably more knowledge accumulation and if I can get them to analyze then synthesize that would be fantastic . . . and in a graduate class you can take them to synthesis because synthesis is where today’s economy and globalization is, where the value is—an employer values your skills if you can synthesize, so those are the skills that we should shoot for. I mean just 25 years ago having the information was enough but today you have to do something with it—and to do something with the information—this is my personal view—I think that you have to have a concept map of how this information fits into the bigger picture—how I can use it in a bigger scheme of things. I would, you know, give them some examples of where they can use it or I can tell them to use it in situation a or in situation b, but the only test if they really learned it is if they can really use it in situation c. (Dr. K Interview 1, 3/30/06)

From this conversation I identified Dr. K’s espoused beliefs about his own approaches to learning. He indicated that he must first accumulate the knowledge, analyze it, and then synthesize it in order for him to add the new knowledge into his existing schema. In turn,
he may have to re-analyze or re-synthesize new material if it does not fit with his existing schema. The descriptions of Dr. K’s approaches to learning were consistent between interviews. There was no mention of technologies when describing his approaches to learning.

**Desired Learning Outcomes of the Course**

Dr. K stated that he believed students met the objectives for his course if they were able to understand design processes and good machining in order to design a new and improved design with their own understanding. In looking back at the objectives of the course, I was able to identify that Dr. K’s espoused beliefs about his course objectives led him to direct his students in various directions so that his students could learn to make sense of the information meaningfully in multiple contexts. The descriptions of Dr. K’s desired learning outcomes were consistent between interviews. In the first interview, he stated:

Okay—one thing is they know that if they were faced with a new manufacturing process, in this case, the new machining process, then they can kind of strip it down in its fundamental units and know how to analyze it—once they have analyzed it then they can utilize the information to improve the design [or use it in a different context]. So if they can do that, I think the course met its objectives. (Dr. K Interview 1, 3/30/06)

This answer helped me identify Dr. K’s espoused beliefs about his desired learning outcomes for his course. He stated that he believed students met the objectives for his
course if they were able to apply the materials learned in class to different contexts. In the second interview, he indicated that students should:

…understand how to design an effective and efficient machining process, they understand what it takes to do good machining, and they understand how to predict the behavior of the machining process, and then they can design a new and improved design with their own understanding. (Dr. K Interview 2, 4/25/06)

Dr. K did not discuss technologies when describing the desired learning outcomes of his course. The lack of technology related responses were consistent in the interview apart from the minor aspect of concept mapping using technology.

Dr. K’s Teaching, Including His Use of Technology

This section introduces Dr. K’s teaching, including his use of technology. The section begins with a description of Dr. K’s course in order to identify the context for the classroom observations. Following the description of Dr. K’s course, evidence from three observed classroom lectures is provided in order to identify his teaching, including his use of technology. These results are presented below.

Dr. K’s Course

Dr. K’s graduate course, as part of the graduate studies in Mechanical Engineering, identified the mechanics of machining and finishing processes, such as the mechanics of material removal for ductile materials, shear zone theory, oblique cutting, heat transfer in machining, and various other aspects as defined in the university’s course catalogue (the description in the course catalogue was not quoted in order to maintain confidentiality). He
taught his course in an EDE classroom, a technology-equipped classroom, developed for delivering courses at a distance (see Chapter 3 for further details about the EDE context).

Dr. K’s EDE classroom shown in Figure 4.1 included three video cameras mounted in three different areas around the classroom: one overhead camera directly above the professor for recording instructors in-class annotations on blue note paper; one camera mounted in the center of the classroom ceiling to view the professor, the projection screen, and the Smartboard located towards the front of the classroom; and one camera mounted in the front-right of the classroom to record students and faculty included in the middle and back of the classroom. The classroom also included five television screens, two of which the professor used to view his teaching and three for the students to view the course materials presented by Dr. K during the lecture sessions.

The course began at 3:30 p.m. and concluded around 4:50 p.m. on Tuesdays and Thursdays. Twelve students were enrolled and completed the course: The students enrolled in the course, including male and female enrollment, are outlined in Table 4.2. The off-campus students were working professionals in industrial environments throughout the U.S. They were taking the machining course to receive another form of certification or academic degree as part of their job. They were unable to attend the on-site lectures during the school year, so they viewed the streaming lectures (real media files of the real-time recorded lectures) through WebCT. When their time permitted they called into the classroom during the class time to ask questions or discuss issues with both the professor and on-campus students. All distance students were required to make presentations to the
Figure 4.1. A Diagram of the EDE Classroom where Dr. K and Dr. J Taught.
Table 4.2. The Number of Students Enrolled in Dr. K’s Course, according to Gender and On/Off-Campus Students

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-campus students</td>
<td>1</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Off-campus students</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>

whole class (see later), only one off-campus student called into the class to participate in one of the lectures. I did not observe this particular lecture, but discussed it with Dr. K during the first interview (Researcher notes, 3/30/06).

The on-campus students attended most of the live lecture sessions (Researcher notes) and were also able to view the streaming lectures through WebCT outside of class time. For on-campus students, this was considered a blended learning course, according to the definition by Graham (2006): “Blended learning systems combine face-to-face instruction with computer mediated instruction” (p. 5).

One EDE student producer prepared and recorded Dr. K’s course to DVD for archival purposes and encoded the streamed lecture to real media format for students to view online. The student producer helped Dr. K set up his course, including uploading lectures and enabling the course microphone (I helped with these tasks occasionally) and relayed messages from this professor to EDE staff (e.g., off-campus presentation dates and quiz information). Dr. K did not use the Tablet PC to record his lectures, only video of him teaching and the PowerPoint file were stored in WebCT (as described in Chapter 3).
Throughout the semester, Dr. K kept all of his course information on his pen drive for easy accessibility (Researcher notes, 4/6/06). When Dr. K brought his pen drive to the EDE department, he told the staff members where he wanted the items to be placed within his WebCT environment, and student worker or one of the EDE staff members would upload his course information to this environment. Once the course was complete, the student worker uploaded the new materials developed during that lecture for students to access at their convenience on WebCT.

The WebCT environment was used for course delivery. It was password protected and accessible only to registered students of the course. Dr. K facilitated his WebCT course with the help of the student worker and EDE staff members. He uploaded and linked his course outline to WebCT for his students to view and download. The course outline included the recommended textbooks, the course topics, the course’s grading policy, and the references to be used in lecture. The assignments were not posted on the course outline, but were referred to during the lectures. For example, Dr. K relayed information about a semester-long, phased paper, including three progress presentations. All students, including the off-campus students, were required to complete the papers and presentations. The off-campus students were required to call in three different times during the semester to give a presentation: a proposal presentation, a progress presentation, and a final presentation that described a certain machining process (Researcher notes, 3/30/06). All off-campus students participated in the presentations. Dr. K also relayed information about referred readings during the lectures; these readings were posted in the course outline and were discussed in lecture, such as when they were to be read.
If students had questions about the course materials they could email Dr. K or meet him during his office hours. He made himself available during his office hours from 1:00–3:20 p.m. before his class began on Tuesdays and Thursdays for students with questions. He also checked his email at least once a day to answer students’ questions about the course and course projects (Researcher notes, 3/30/06).

Classroom Observations

The classroom observations are described below using a variety of voices to provide multiple perspectives and to triangulate the different data sets. The multiple perspectives communicate a deeper understanding. These voices are: mine, as an observer of Dr. K’s classroom practices during real-time lectures; the on-campus students who participated in a focus group; and the off-campus student who participated in a telephone interview and answered the same questions that Dr. K answered in his interviews. Course materials and documents (streaming lectures, WebCT, course outline, etc.) are also used.

Three of Dr. K’s lectures in an EDE technology-equipped classroom were observed. I was interested in observing these three lectures because Dr. K had stated that these three lectures would flow from grinding processes in the first lecture to the application of grinding processes in the real world in the third lecture (Researcher notes, 3/30/06). He stated that I would need to observe only the lectures on 4/6/06, 4/11/06, and 4/13/06 to understand the flow of his course. All three lectures were observed to be similar in that Dr. K presented course information to the students, although each lecture contained different content information about the machining process. The flow of the lectures I observed varied from the flow described by Dr. K during the first interview.
Each of the three classroom lectures lasted for 1.5 hours. Please see Chapter 3 for the observation pro forma that was used to take notes during the observations. During the observations, I (as an EDE staff member) helped the professor upload his lecture notes before and after class (during various lectures), helped the student producer shut down the room after the class was over, and posted announcements and a quiz on the course’s WebCT homepage.

**Lecture 1: 4/06/06.** For the first observed lecture, I uploaded the PowerPoint to Dr. K’s WebCT environment, within the Lecture Notes link, and then followed Dr. K to his classroom and uploaded the lecture for him again on the instructor PC, one of which was located in each of the EDE technology-equipped classrooms. This was typical of the process that occurred before and after EDE course sessions.

Dr. K told the students that his intention for this lecture was to discuss grinding and the history of grinding. At the beginning of the lecture he stated the objectives:

- Students must know what to do and why they are doing it;
- They should want more and more accuracy, so they must find tools to meet the purpose;
- To discuss wheel structure and grade. (Researcher notes, 4/6/06)

I observed that Dr. K wanted the students to think about the course materials and try to understand them (I could see the anticipation in his face); he asked the students many different questions throughout the lecture to see if they understood the materials, although some students did not appear as excited about the course objectives as Dr. K. For this lecture, Dr. K embedded three simulations into his PowerPoint slides in order to help the
students “see” the grinding process. The simulations demonstrated different grinding processes in order for the students to understand the fundamentals of the grinding process.

During the lecture observations, I observed that Dr. K’s students would sometimes answer questions, but other times he would answer the questions himself and move on to the next concept. During the focus group, one student stated that Dr. K “tells us what to expect in this lecture, but in between some of them are much more quite boring lectures, sometimes we are kinda lost, sometimes very lost in some of the lectures, to be honest” (Student 1, Focus Group, 4/6/06). From this student’s perspective, the students in the course “are so lost that we do not know where to start, we are lost” (Student 1, Focus Group, 4/6/06).

I observed that Dr. K employed a lecture-based technique throughout the lecture by sitting in front of the class presenting information to his students. From one student’s perspective the lecture was:

…pretty much lecture based . . . he kind of dumps the information on us and when we are doing our project and [if] there is something that we don’t know then we can ask him something about that—it may be something indirect, [that] is not lecture style (Student 1, Focus Group, 4/6/06).

*Lecture 2: 4/11/06*. For the second observed lecture (Lecture 2, 4/11/06), the student producer uploaded the lecture PowerPoint to both WebCT and the instructor’s PC, and after finishing uploading the lecture, the student producer finished preparing Dr. K’s course by turning on his microphone and opening his PowerPoint file. The student producer followed the same intro and exiting sequence as described in Chapter 3.
During the beginning of this lecture, Dr. K stated that his intentions were to continue with grinding, specifically “force per grit,” and to prepare the students for an open-book, open-note quiz. Dr. K affirmed that he had posted a sample quiz on WebCT for the students to look over and that the posted sample quiz was going to be quite similar to the open-book, open-note quiz (Real Media File, 4/11/06; Researcher Notes, 4/11/06).

I discussed the open-book, open-note quiz with one of Dr. K’s students during the focus group interview:

Student 1: Yea, so more like research time, what he is teaching in class . . . he does not give a test on every lecture . . . this quiz is the only one we have had in the whole semester

L: Oh wow!

Student 1: Yea, and it is open book, so probably he . . .

L: Wow, the hardest!

Student 1: Yea, the hardest and he probably does not expect us to memorize everything, but instead you know that there is this stuff and see if you can apply it in your project. It is kind of like research and it is kind of like your own ideas instead of learn this and learn that . . . you don’t expect to memorize everything.

L: Excellent, so do you think that he leaves it open so that you guys can learn it in a way that you can make sense of it?

Student 1: Yea, make sense of it and sometimes I remember this and really try to apply it. (Focus Group, 4/6/06)
From the last statement it appears that this student and Dr. K espoused similar beliefs on learning (please see *Approaches to Learning* above).

I observed that the students asked about the same number of questions and answered some of Dr. K’s questions (around four or five times) during each lecture observed thus far, as well as took notes and listened meticulously to the highly informative lecture. There was a large amount of content presented to the students during this lecture.

*Lecture 3: 4/13/06.* For the last observed lecture (4/13/06), the student producer again uploaded the lecture presentation to both WebCT and the instructor’s PC and, after finishing uploading the lectures, finished preparing Dr. K’s course by turning on his microphone and opening his PowerPoint file. The student producer followed the same intro and exiting sequence as described in Chapter 3.

During the beginning of this lecture, Dr. K stated that his intentions were to discuss “the chemical mechanical planarization process” (Researcher notes, 4/13/06). I did not know if this term meant loading and unloading, which was what he said would be the focus of this lecture during Lecture 2 (Researcher notes, 4/11/06). Dr. K’s objective for this lecture was to have his students understand the CMP process. However, this objective was not clear to all the students in the class. An off-campus student stated that: “[Dr. K] has an issue . . . his issue is that he is unable to be clear on objectives or requests” (Off-campus student interview, 5/4/06). The off-campus student also stated that Dr. K “understands the material, but at times he is unable to deliver the ideas and I think it is do to lack of experience or—it is like you can always learn but it is not always easy to teach” (Off-campus student interview, 5/4/06).
Dr. K lectured for around an hour without stopping and then asked questions after he had moved through many different slides and a lot of information; the class began at 3:30 p.m., and he did not ask if there were any questions until 4:21 p.m. (Researcher notes, 4/13/06). The students sat back and stared at him without asking any questions. This may have been because the students were already on task with what he was teaching or overwhelmed with the wide array of content disseminated during this particular lecture.

In the syllabus Dr. K cited many different reference papers for students to read before the lectures in order for them to compare and contrast the articles’ findings with their own understanding of the materials (Dr. K Interview 2, 4/25/06). He stated that he would like his students to “come up with their own theory or design or they will at least critique things—like, based on what I have seen in five articles this is what I believe in or this is what one should do (Dr K Interview 2, 4/25/06). Two students touched upon reference paper readings during the focus group interview:

Student 2: Yea, but before every class he asks us to read the reference paper about what he will teach in this class.

Student 1: Yea, reference paper.

L: Good.

Student 2: Yea, every class, it was excellent.

L: So, do you feel that that is really helpful to kinda prepare you before what he will be discussing, so you can see what will be covered?

Student 2: Yea.
L: Is it more informative or is it more of this is what somebody else did and here are their findings or is it more about this is a description of what it is and what you can do with it? Is it more information or I guess practical or does it differ with different topics?

Student 1: I guess it differs with different topics because sometimes he asks us to read, like ummm, he posts [on WebCT] some chapters that he got from the book that would be much more informative and umm most of the cases he asks us to read are research papers done by some graduate students at other universities.

L: Great.

Student 1: Yea, he kind mixes it up. (Focus group, 4/6/06)

From the focus group interview, it appears that the students enjoyed having the accessibility to the wide array of articles, because they could learn what others were doing and could learn what to do or what not to do according to the articles.

I observed that when students were asked a question that they could not answer, Dr. K repeated the material in a different context and with a different metaphor to try to make students think about the material in a way that made sense to them. Dr. K did not specifically ask the students if they understood the information or if one of them could explain the information in their own words. He told some of his stories from his past experiences and discussed concept mapping as a cognitive process during this lecture, but did not specifically ask students what they thought about the concept.
The First Case Study’s Findings

The main objective of this research investigation was to examine the phenomenon of one faculty member’s espoused beliefs and his classroom practices using technology to see if there were any similarities or differences between his espoused beliefs and teaching practices using technology (Martin et al., 2000). The research question that guided this analysis was: How do an engineering faculty member’s espoused beliefs relate to his/her observed classroom practices using technology? In order to understand the phenomenon of Dr. K’s espoused beliefs and classroom practices using technology, I examined the similarities and differences between his espoused beliefs and his classroom practices. To support these findings, Dr. K’s espoused beliefs and classrooms practices were described in an exemplary vignette and then compared to Martin et al.’s findings from Dr. Leon. The section concludes with a summary of the findings.

The Phenomenon of Dr. K’s Espoused Beliefs and His Classroom Practices Using Technology

In order to explain the phenomenon, I followed Yin (2003) to “stipulate a presumed set of causal links” (p. 120) among all data collected and analyzed. These causal links enabled me to explain how one engineering faculty member’s espoused beliefs relate (are similar to or different than) to his observed classroom practices using technology, as summarized in Table 4.3.

Dr. K’s espoused beliefs and his observed classroom practices were related, except there were a few differences identified between his teaching approaches and the way in which he managed his course. Dr. K used different teaching approaches in his classroom in
Table 4.3. Similarities and Differences (Causal Links) Between Dr. K’s Espoused Beliefs and Classroom Practices Using Technology

<table>
<thead>
<tr>
<th>Espoused beliefs</th>
<th>Classroom practices</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teaching approach</strong></td>
<td>Dr. K’s espoused a student-centered teaching approach.</td>
<td>Dr. K aimed for his students to develop their own conceptions of the discipline by giving his students massive amounts of content from different contexts and different authors in order for students to understand multiple perspectives of the concept. This way the students would be able to assimilate and/or accommodate new knowledge into their pre-existing schema. I observed some student-centered approaches in the classroom.</td>
</tr>
<tr>
<td><strong>Main objective</strong></td>
<td>To understand fundamentals of machining process and learn how to effectively do manufacturing design.</td>
<td>To understand fundamentals of machining process and learn how to effectively do manufacturing design.</td>
</tr>
<tr>
<td><strong>Course management</strong></td>
<td>As a facilitator (espoused belief) and a content expert (observed classroom practice using technology).</td>
<td>Dr. K aimed for his students to develop their own conceptions of and/or change their conceptions of the discipline.</td>
</tr>
<tr>
<td><strong>Role of technology</strong></td>
<td>• Technology as a tool for teaching (e.g. PowerPoint) • Course access (anytime and anywhere) • Reach students all over the world • Improve course delivery</td>
<td>• Technology as a tool for teaching (e.g. PowerPoint) • Course access (anytime and anywhere) • Reach students all over the world • Improve course delivery</td>
</tr>
</tbody>
</table>
order to transmit all of the course information to his students. He taught the students in a way that enabled them to develop their own understanding of the materials (Lecture 1, 4/6/06; Lecture 2, 4/11/06; Lecture 3, 4/13/06). He did not facilitate discussion.

Similarly, Dr. K managed his course differently from his espoused approach to teaching. During the classroom observations, he used his expertise in the content to transmit all of the course information to his students, and he was a facilitator, but only in that he addressed the course content with multiple perspectives so students could develop their own understanding of the materials (Lecture 1, 4/6/06; Lecture 2, 4/11/06; Lecture 3, 4/13/06).

Vignette of Dr. K

This section provides an exemplary vignette of the ways that Dr. K described his teaching beliefs and the relationship between his espoused beliefs and his approaches to teaching using technology (the outline was adopted and modified from what Martin et al., 2000, referred to as a vignette). The vignette is a descriptive story of the relationship between Dr. K’s espoused beliefs and his classroom practices and includes the relationship between his espoused beliefs and classroom practices, including the use of technology, descriptions from observations from his classroom, his approaches to teaching with technology, and his reflection on his own classroom practices.

The relationships are described below using the following outline (adapted and modified from Martin et al., 2000, p. 398–400): What is it that you teach to your students?; what must your students know?; how will your students be brought into active connections
What Is It That You Teach to Your Students?

Dr. K discussed an agenda with his students during his first observed lecture. His agenda focused on first telling his students that they must understand what they need to know about machining processes, specifically to understand why they are doing the processes. Similarly, during the first interview, I identified that Dr. K’s graduate course objectives aimed:

…to get the students to understand [the mechanics for machining and precision finishing processes] so that they are able to analyze the machining processes into these different facets and then [students] are able to understand it and utilize it in hopefully designing a manufacturing process. (Dr. K Interview 1, 3/30/06)

The second agenda item was to teach his students how to be more accurate when designing processes. In comparison with his espoused beliefs, during the second interview, Dr. K’s course objectives aimed:

…to make the students understand what are the fundamental issues in machine processes and how they can make the processes more effective and more efficient and to put these things together to design processes. . . . Another objective would be to help them in thinking how to design better manufacturing processes and connect it with thinking about manufacturing in general. (Dr. K Interview 2, 4/25/06)

The third item in the agenda addressed machining tools. Dr. K expressed to the students that these tools were necessary for students to understand in order to design effective
machining processes (Dr. K Lecture 1, 4/6/06). This type of agenda was evident before each observed lecture to focus the students on the topic at hand.

What Must Your Students Know?

During the first interview, I identified that Dr. K aims for his students to know that if they were faced with a new manufacturing process, in this case, the new machining process, then they “can kind of strip it down in its fundamental units and know how to analyze it—once they have analyzed it then they can utilize the information to improve the design” (Dr. K Interview 1, 3/30/06). He also focuses on teaching his students to “understand what it takes to do good machining and they understand how to predict the behavior of the machining process . . . and then they can design a new and improved design with their own understanding” (Dr. K Interview 2, 4/25/06).

Dr. K’s intentions were to teach his students the knowledge necessary to learn the course materials successfully; that is, to have the students understand the fundamental theories and processes in their own words, within their own context, and with the correct tools. In doing so, he expressed that his students would be able to develop and improve design processes (Dr. K Interview 2, 4/25/06).

How Will Your Students Be Brought into Active Connections with That Knowledge?

Dr. K discussed the flow of his course, from his perspective, during the first interview. The flow was developed as one approach to bring students into active connections with the course materials. Dr. K stated:
[I] first [cover] some basics of the manufacturing process so they understand the fundamental aspects and then I cover from some research papers and that is like the intermediate step and then you will see that in the next couple of lectures that I will start talking about some design aspects, so that is kind of the flow of the course . . . and [the students] will see how to use all of these fundamentals to design the process. (Dr. K Interview 1, 3/30/06)

Dr. K also invites guest lecturers to his course live, or at a distance, as a way of giving his students another perspective of the content being covered. He expressed that he wants his students to be able to understand the materials in a way that is meaningful for them so that they can apply their understanding in any context with which they are confronted. He believes that multiple perspectives can help students understand the knowledge in multiple ways; ways that may align with the students’ own ideologies (Dr. K Interview 1, 3/30/06).

Dr. K described how he presents course information to his students. He presents information in such a way that it models his own expectations for his students’ three presentations:

Dr. K: Well, the way the course is supposed to work is that I discuss different articles and these articles discuss manufacturing and machining from different points of views, so in my presentation I try to compare and contrast them—like this is a theory and it has its assumptions and either it has strengths and weaknesses and the idea is that the students in their presentation—they are supposed to tell me what they thought of it and what they thought out of reading these four or five different articles—the students let me know what the theory should be—okay.
L: Right, do they have certain assigned articles or . . .

Dr. K: They choose a topic . . . and then associate it with the topic of similar articles.

L: Okay.

Dr. K: And, then also they can go a step beyond and say—okay if these are the facts then how can do you design a process that is based on those? (Dr. K Interview 2, 4/25/06).

Dr. K focuses on actively connecting students with the course knowledge through his course presentations (which includes PowerPoint presentations and blue note paper). A specific example given by him was:

Using the PowerPoints, compared to writing on the board, okay, if you use it right, use it at the right place, then I think that definitely enhances the learning, it enhances how the students see things, they get the notes, okay, but also if you use it at the wrong place, for example, a derivation of an equation is important, okay, there I think, deriving it on the board is better because when you are doing it, it gives the students another perspective, they get to see how you are doing it, rather than seeing a bunch of formulas on the screen, you know, like that. . . . Because what happens is, I show them two steps and on the PowerPoint it is too fast, and they do not have the time to make the connection and realize how you go from one step to the other, but if you somehow . . . maybe a third way would be . . . do the PowerPoint and slow it down, okay, like you show one equation and then another equation and then maybe do it that way. (Dr. K Follow-up Interview, 9/1/06)
From my perspective, Dr. K was always aware of his students, what his students knew, and what his students did not know. His students’ needs always came first, and he would address any issues that they were confronted with throughout the duration of the course.

Teacher’s Observed Practice

Dr. K’s classroom approach, observed from the three lectures, was a traditional lecture-based format. This was evident from how he sat behind the desk at the front of the classroom, facing all the students. He covered massive amounts of content materials presented to the students in a sequential order with the help of PowerPoint slides and blue note paper. I observed that he had around 20 PowerPoint slides per lecture session (Researcher notes, 3/30/06).

Dr. K did not engage his students in discussion about the course materials, although he stopped periodically during his lecture presentations to ask the students questions about the course materials previously covered in the lectures. For example on one occasion, he asked the students one question during lecture 3 and waited for about 1 minute until students said something. However, the students’ response was not what he was aiming for, so he went back and described the information over again (Lecture 3, 4/13/06). Although Dr. K was very focused on having his students understand the fundamental elements of machining processes, his lecture style did not encourage student discussion of a concept at any time.
Teacher’s Approaches to Teaching with Technology

From interview sessions with Dr. K, it was apparent that he was intrigued with the use of technology in his classrooms and believed that he could reach many students all over the world with his teaching. He stated that:

…one thing that was wonderful was the ability that the off-campus students could present from being off campus and without the technology I would not have had this capability. They could do their presentation from off-site and that was good. . . . I knew [they were connected into the classroom] because they asked questions and then I knew they were there. (Follow-up interview, 9/1/06)

Dr. K described his view of technology as “any tool, like science, you can use it to help you, help others, you can also use it to hurt yourselves, and hurt others, okay, and my view of technology is the same, okay” (Follow-up interview, 9/1/06).

In terms of approaches to teaching with technology, Dr. K described inertia when adopting technology:

You have a lot of inertia because you have been doing it this way for so many years and I think doing this one definitely made me more aware of how you can use PowerPoints and now I have taught distance education a few times I am more comfortable, I mean for example, initially when that question would pop up on the [the chat message box with off-campus student questions] and it would be a distraction . . . but after a bit you get used to it…and the [on-campus] students get used to it. (Follow-up interview, 9/1/06)
From my perspective, Dr. K focused on using technology as a tool to help students learn the materials more effectively and to reach them at a distance. It was evident from the interviews that he reflected on his approaches to teaching and teaching with technology.

Teacher’s Reflection on Practice

Dr. K espoused beliefs that all people, in general, have a concept map that has all life experiences categorized and organized in their minds. These life experiences shape who people are as they grow and mature within society. Dr. K reflected on this concept using a mapping metaphor:

First you have to accumulate the knowledge and then you have to analyze it and then you try to synthesize with it and in a undergraduate class it is probably more knowledge accumulation and if I can get them to analyze some synthesis that would be fantastic . . . and in a graduate class you can take them to synthesis because synthesis is where today’s economy and globalization is where the value is—an employer values your skills if you can synthesize, so those are the skills that we should shoot for. (Dr. K Interview 1, 3/30/06)

Dr. K Compared to Dr. Leon

After describing the relationship between Dr. K’s espoused beliefs and his classroom practices using technology through this vignette this section compares the results to Martin et al.’s (2000) vignette of Dr. Leon. The category of description for the object of study (according to Martin et al. and as described in Chapter 3) with which Dr. K was identified was Category C: “Student understanding of the subject matter in relation to the
discipline as a whole. The teacher introduces a body of knowledge and the ways in which this knowledge has been developed is explored and applied” (Martin et al., p. 393). The category of description for approaches to teaching (according to Martin et al. and as described in Chapter 3) with which Dr. K was identified was Category D. According to Martin et al., in this category:

The teacher engages students with discipline knowledge with the intention of helping students develop their conceptual understanding. The teacher’s intention is to enable students to learn the material through demonstrations of the principles to be learned and through the use of examples related to the student’s own experiences. (p. 395)

The relationship between Dr. K’s and Dr. Leon’s espoused beliefs and classroom practices using technology is classified in Table 4.4 as C/D.

When compared to the results from Martin et al. (2000), Dr. K’s categories, C and D, were a fit with four of the interviewed teachers from Martin et al.’s research investigation. From this analysis, a close relationship exists between Dr. K’s course objectives and his approaches to teaching.

Dr. Leon was one of the four teachers identified as being Category C (object of study) and Category D (approach to teaching) in Martin et al. (2000, p. 403), although he taught a different discipline within a different context than Dr. K. Similar to Dr. K, Dr. Leon’s intentions were to present his course materials to his students coherently and with meaning in order for his students to be exposed to the “processes of constructing the theory base, as well as to the resulting body of knowledge” (Martin et al., p. 403). Dr. Leon,
Table 4.4. The Fit Between Dr. K’s and Dr. Leon’s Espoused Beliefs and Teaching with Technology (according to Martin et al., 2000).

<table>
<thead>
<tr>
<th>Approaches to teaching</th>
<th>Object of study</th>
<th>Knowledge given</th>
<th>Knowledge constructed/problematic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Teacher focus</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student focus</td>
<td>D</td>
<td></td>
<td>Dr. K</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td></td>
<td>Dr. Leon</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

according to Martin et al. (p. 403), wanted his students to learn from and connect with the course materials, so he would expose them to ways that the discipline was constructed, developed, and explored. This was similar to Dr. K, who brought guest speakers and various contrasting articles to class in order for the students to understand the fundamentals of the machining process from multiple perspectives.

Dr. K’s and Dr. Leon’s observed practices were similar in that they both aimed to improve student understanding of the content materials. Dr. Leon conducted experiments in class, asked students for their reaction to the experiments, and moved on to the next lecture according to the closing thoughts and student-directed questions. Dr. K, on the other hand, sat at the front of class, presented information to his students using his PowerPoint
presentations, which sometimes included embedded simulations, and asked his students questions periodically. The similarities between professors were that each professor demonstrated the concept with an example and that when the students asked questions or got answers wrong, both Dr. K and Dr. Leon would answer the question using various and contrasting examples until the students nodded their heads (Researcher notes, 3/30/06).

Both Dr. K and Dr. Leon reflected on their practice. Dr. K believed that his students’ concept maps (their life experiences organized in their minds) enabled them to accumulate, analyze, and synthesize the course content. In contrast, Dr. Leon believed that doing an experiment in his course enabled his students to think about and connect the materials with real-world experiences (Martin et al., 2000).

Summary

The first case study examined the relationship between Dr. K’s espoused beliefs and classroom practices using technology. In order to understand the relationship, I conducted an analysis of multiple data sources. The findings indicated that Dr. K’s espoused beliefs and classroom practices, including the use of technology were different in his approaches to teaching and the way in which he manages his course (see Table 4.4).

Proposed Improvement for Research of a Second Case Study

The research methods and analysis used for this case study were successful and were used again to examine the second case study, presented in Chapter 5. Although the case of Dr. K was successful, technology-related aspects were sparse. To increase the technology dimension of this research, technology-related questions were added to the
semi-structured interview design (please see Chapter 3). In addition, I improved the selection of the second case to strengthen the technology aspect. This second case is analyzed and described in the following chapter.
CHAPTER V

THE SECOND CASE STUDY: DR. J

Introduction

This chapter provides a case study of a second engineering faculty member’s espoused beliefs and classroom practices using technology. The findings begin by introducing Dr. J (pseudonym), the faculty member, followed by a description of his course, the context. Following the description of his course, Dr. J’s espoused beliefs are presented. The findings from Dr. J’s teaching, including the use of technology are then described, followed by an analysis that compares and contrasts his espoused beliefs with his teaching. The phenomenon of his espoused beliefs and classroom practices using technology is then presented, followed by an exemplary vignette of his teaching compared with the findings from Martin et al. (2000). The findings end with a summary of this case study. The chapter concludes with proposed improvements for future research studies.

The Engineering Faculty Member, Dr. J

During the first interview, I was able to identify Dr. J’s background experiences that led him to become a professor in the College of Engineering at this midwestern university. Dr. J discussed how he loved math as a child and received advice from both his math teachers in high school, his coach, and his guidance counselor, to focus on a mathematics career; his mother was a teacher, “so [he] thought [he] would try [it]” (Dr J Interview 1, 11/13/06). Dr. J completed his undergraduate degree in mathematics and then went into the Air Force.
When Dr. J completed his time in the Air Force, they tried to send him to the Air Force Institute of Technology, “which is grad school” for the Air Force (Dr. J Interview 1, 11/13/06), but Dr. J had found interest in the field of industrial engineering:

One of the programs there (at the Air Force Institute of Technology) is operations research, there is also systems engineering, and I did not have a clue what operations research meant, so I did a little investigating and was like . . . geez, you can use your math and so when I got out I started looking at different programs and that is when I found IE [Industrial Engineering] and found out that, oh, operations research is often within [IE] and that is how I kind of stumbled into it. (Dr. J Interview 1, 11/13/06)

Therefore, Dr. J came to this midwestern university in the early 1980s to pursue his master’s degree. He “did not have an undergraduate in engineering, [so he] had to take [a lot of] credits of undergraduate coursework” (Dr. J Interview 1, 11/13/06). For one quarter, he also helped a professor in a freshman level course grading homework assignments. He began his master’s thesis work, but he did not finish: He went to work for a company that was the leader in world tire technology.

Dr. J discussed how he moved to Wisconsin to pursue his Ph.D. He had not completed his master’s thesis, so he came back to this university for a summer. During this time he was a classroom instructor for the first time: He stated that, “there was really no preparation for it . . . you know it was like here, just throw you in” (Dr. J Interview 1, 11/13/06). He completed his masters in 1986 and his Ph.D. in 1988 and came back to this
university in 1988 as a tenure-track professor, basically “thrown [into the position], which is typical for a faculty [member]” (Dr. J Interview 1, 11/13/06).

Dr. J, as a professor in the College of Engineering at this university, taught a majority of his graduate courses through EDE. I worked with Dr. J during the Fall 2004 semester through to the present semester and had already established a positive, working relationship with him. I identified early on, from prior conversations and course facilitation meetings, that he was intrigued with the use of a variety of technologies in his classroom and believed that he could learn any new technology and its applications within his content area.

Dr. J stated that he would use the same technologies during this study that he had been using in his course (Dr. J Interview 1, 11/13/06; Dr. J Interview 2, 12/14/06). He said that he “doesn’t know if [he] would change anything . . . other than maybe use more than what [he] already has been using” (Dr. J Interview 1, 11/13/06). He also stated that “if something new comes out [he] will try it” (Dr. J Interview 2, 12/14/06).

Dr. J’s Course

This section describes Dr. J’s graduate course, as part of the graduate studies in Industrial Engineering. His course aimed to uncover an organized multidisciplinary approach to designing and developing systems, such as the concepts, principles, and practice of systems engineering as applied to large integrated systems; life cycle costing; scheduling; risk management; and various other aspects as defined in the university’s course catalogue (the description in the course catalogue was not quoted in order to
maintain confidentiality). This course was the first course in a two-part series of courses on systems engineering.

He taught this course in the same EDE classroom as Dr. K (please see Figure 4.1 for the layout of the EDE classroom). There was one EDE student producer who prepared and recorded his course to DVD for archival purposes and encoded the streamed lecture to real media format for students to view online. The student producer helped him set up his course, which included uploading the PowerPoint lecture to the Tablet PC, starting the recording of the Tablet PC with Camtasia, and enabling the course microphone (I helped with these tasks occasionally). The student producer also posted course materials at the end of each lecture session on WebCT and relayed messages from the professor to EDE staff (e.g., off-campus evaluations).

The WebCT environment was accessible to registered students of the course. The off-campus students were working professionals in industrial environments throughout the United States who were taking the systems engineering course to receive another form of certification or academic degree as a requirement for their job. They were unable to attend the real-time lectures during the school year, so they viewed the streaming lectures (real media files of the real-time recorded lectures) through their password protected WebCT environment (one online environment used by this university). The on-campus students attended the live course and were able to view the streaming lectures outside of class time.

The course was scheduled to begin at 8:00 a.m. and end around 9:15 a.m. on Mondays, Wednesdays, and Fridays. Dr. J made himself available for both on- and off-campus students either during his office hours (Tuesdays and Thursdays) or during a
specified time indicated by the student. He expressed during the interview that “off-campus students don’t pay attention to that . . . and although [he] posts his office hours . . . [he] always tell[s] students that that is just a timeline [of] when [he tries] to make sure that [he is] in [his] office” (Dr. J Interview 1, 11/13/06). He affirmed that anytime he was in the office that students were able to call him or come to his office to visit and stated that he spent “at least 45 minutes to an hour a day” (Dr. J Interview 1, 11/13/06) answering student emails and communicating with students over the telephone about course related issues. Dr. J’s students stated consistently in the interviews that they could email the TA or Dr. J if they had questions about the course materials.

Dr. J’s course was a typical course with a typical student constituency (Researcher notes, 2/13/07) that included 75 students, 64 of which were off-campus students (see Table 5.1). Student demographics are portrayed in Table 5.2. Due to the large number of students enrolled in the course, Dr. J hired a TA, intentionally from off campus, to help him grade the homework assignments, because he did not believe anyone on campus was qualified for this course (Dr. J Interview 1, 11/13/06).

The TA was employed at a company deemed a leader in the design, production, and support of communication and aviation electronics for customers worldwide. Three out of five off-campus student participants in this research investigation were employed at the same company. Two of them said in their interviews that there were at least 20–30 students in this class at their company and that one of those students took the initiative to email everyone, “and [some of them] started up watching lectures together to kind of keep each
Table 5.1. The Number of Students Enrolled in Dr. J’s Course, according to Gender and On/Off-Campus.

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-campus students</td>
<td>3</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Off-campus students</td>
<td>16</td>
<td>48</td>
<td>64</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>52</td>
<td>75</td>
</tr>
</tbody>
</table>

Table 5.2. Student Demographics for the Second Case Study

<table>
<thead>
<tr>
<th></th>
<th>Caucasian</th>
<th>Indian</th>
<th>Turkish</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Male</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
</tbody>
</table>

other in check” (Off1 Interview, 11/10/06). Even though this option was available for both of these off-campus students, they both declined and never took part in the group activity. Two of the off-campus students had separately discussed the course with a few other students in their building who were also taking the course (Off1 Interview, 11/10/06; Off4 Interview, 11/14/06). One of these students took this one step further and contacted fellow students in his area so that he could meet and work with them to talk “about different issues” (Off4 Interview, 11/14/06). One off-campus student in particular stated that the TA was located in his building, so he could walk to the TA’s office if he had a questions about the course (Off4 Interview, 11/14/06).
Dr. J’s Espoused Beliefs

**EBI Results**

Dr. J’s EBI results (shown in Table 5.3) identified a range of epistemic beliefs. Dr. J believed that knowledge is neither simple nor complex (Simple Knowledge), it is handed down by authority (Omniscient Authority), and it is neither certain nor tentative (Certain Knowledge). Dr. J also believed that the ability to learn is acquired (Fixed Ability) and that learning is not quick at all (Quick Learning). The findings indicated that Dr. J agreed with Schraw et al.’s (2002) epistemic belief that authorities have access to otherwise inaccessible knowledge.

The interview data confirmed the EBI results. From my perspective, these beliefs fit best in the cognitive realm of understanding. For example, when Dr. J discussed how he came back to this midwestern university for graduate school, he stated how he studied differently than when he was an undergraduate, because he “tried to learn the material and understand it and then [he] did not have to worry about the exams” (Dr. J Interview 1, 11/13/06), instead of memorizing the material to pass the test. Similarly, Dr. J noted that he wanted his students to approach the content material in the same way that he approached the material in his graduate studies (Dr. J Interview 1, 11/13/06).

**Course Objectives**

Dr. J’s espoused course objectives were to introduce the basics of systems engineering. These were identified consistently in both interviews (initial and final) and his
Table 5.3. The Mean Score for each EBI Category for Dr. J

<table>
<thead>
<tr>
<th>EBI category</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omniscient authority</td>
<td>3.60</td>
</tr>
<tr>
<td>Certain knowledge</td>
<td>3.00</td>
</tr>
<tr>
<td>Simple knowledge</td>
<td>2.57</td>
</tr>
<tr>
<td>Fixed ability</td>
<td>2.43</td>
</tr>
<tr>
<td>Quick learning</td>
<td>1.40</td>
</tr>
</tbody>
</table>

students’ interviews (five off-campus total, two on-campus total). His espoused course objectives were:

The first goal is for [the students] to learn the basics of systems engineering, what are the basics of systems engineering? . . .What is it? Why do we have it? How long has it been around? What do you use it for? and then, what is the general process for systems engineering? . . .After we talk about the process and how you would implement the process and the things you need to consider, what a system engineer does, and so far . . . then we go into the tools that systems engineer would use. (Dr. J 1, 11/13/06)

He also stated that “the main purpose when [the students] get done is to at least have a basic understanding of what systems engineering is . . .” and he noted that everything he discussed in his course in one way or another relates to systems engineering (Dr. J Interview 2, 12/14/06). From my perspective, all of the espoused course objectives helped guide Dr. J through his teaching and the course assignments (Researcher notes, 11/14/06).
Dr. J. used many technologies to help meet his course objectives. PowerPoint was the technology that he used the most in his course to help him improve delivery. He noted that he used “PowerPoint a lot, especially at the beginning [of the course] because [he] covers many qualitative ideas, [as well as] quantitative things . . .” (Dr. J Interview 1, 11/13/06). He “like[s] using the bullets, that helps [him] relay aspects of systems engineering” and he tries to show, “part of the information and then [he and his students] need to expand on that [in class]” (Dr. J Interview I, 11/13/06). Dr. J also explained that he liked using the whiteboard. He noted that he liked:

To be able to write things out . . . kind of work it out . . . do the calculus, instead of always having it already there . . . I mean, I know there is a way that you can do it with a slide, but if you give them the slide it is all there . . . and I would rather have them work it out with me. (Dr. J Interview 1, 11/13/06)

Dr. J posted his lecture PowerPoint slides before class so students could print them out and follow along with them during class (Researcher notes, 11/07/06). Some of his lecture slides portrayed his course content, such as the slides used toward the beginning of the course, whereas other lecture slides gave step-by-step directions on how to use “a tool that a systems engineer might use. . . . A simple one would be a spreadsheet, we do some different things on spreadsheets” (Dr. J Interview 1, 11/13/06).

Dr. J used the Tablet PC to present his PowerPoints, including course materials and screen shots of engineering tools, to his students because the visuals were magnified when projected on the projection screen. He noted that “a better advantage [than showing the students the screen shots] would be that students have a laptop in front of them and do [the
problems] with [him]” (Dr. J Interview 2, 12/14/06). It was clear from both interviews that he did not like to use the Tablet PC because it did not annotate well with him (the pen tool was off when he wrote and it annoyed him), but he used it because it was clear for the students to view and they could follow along with course materials.

Another technology Dr. J used was the overhead camera (Dr. J Interview 2, 12/14/06). He showed specific items from the course textbook and blue notes from previous lectures under the overhead camera (Researcher notes, 11/30/06). The student producer simultaneously showed the camera view to all the students via the television screens and overhead projector. Shots from the overhead camera were also included in the recorded lectures, but in low-rez version only.

*Students’ Active Connections with Course Objectives*

Dr. J recognized that students who have real-world engineering experience were less in need of active learning than his students who have moved straight through the degree programs without experience in the field:

> When I do our dual degree program, we have people that have 5 years of industrial experience and some of them have 15 or 20, it is almost the opposite, you have to shut them up . . . or you don’t get everything covered . . . [In contract,] typically, I have found that with undergrads and even graduate students because many of them go right through [without any real-world experience before graduate school], that they seem less likely to want to participate. (Dr. J Interview 1, 11/13/06)

This led Dr. J to discuss the main source of student interaction in the course, which were the homework assignments (this aspect was consistent in both interviews):
They do have a series of homework assignments [please see Table 3.3] . . . and that is probably the main thing. . . . I do some things where I have them do a homework assignment and they actually share it with another student and they evaluate each other . . . so, that’s how I try to drive the point home by having each person doing it themselves and usually the best way to learn something is to evaluate someone else’s so I do that with one assignment. (Dr. J Interview 1, 11/13/06)

He stated that “the homework always reinforces something that [he has] done in lecture . . . like I talk about Monte Carlo, then [the students] have to do a Monte Carlo . . . I talk about engineering economy, [then the students] have to do engineering economy homework” (Dr. J Interview 2, 12/14/06).

Dr. J indicated that he would like to include group projects into his course, although he believed that “it [would be] hard to do group projects” (Dr. J. Interview 2, 12/14/06). He stated that he has “thought, especially since the class is getting bigger and bigger about pairing [his students] up and even making [a student in the field] work with a non-employee or something” (Dr. J Interview 2, 12/14/06). From my perspective, Dr. J’s espoused beliefs of his students’ active connections with the objectives of his course guided him through his course teachings and the course assignments shown in Table 3.3 of Course Key Events (Researcher notes, 11/14/06 and 12/14/06; Fall 2006 Course Syllabus).

There were also many technologies that he used in his course to actively connect students with the main objectives. Dr. J told how he used software to reinforce materials covered in class (Dr. J Interview 2, 12/14/06). He also noted issues, regarding student access to specific software:
I mean it is the same idea again [as in how he reinforced materials through the homework, described above], the software I use, I particularly talk about things in lecture and then if I am going to use some software we introduce how you would work through things . . . like the general Monte Carlo and here is how you do things on a spreadsheet . . . we talked about simulation and then I did an actual Monte Carlo simulation . . . but I also talk about discrete event simulation [and the students] don’t’ have [access to] the software so I didn’t do it . . . but at least I demonstrated it as an example of the AHP. . . . so things . . . of course we talked about it first, we did it by hand, and they had to do an assignment that involved using a spreadsheet and I also demonstrated a thing called expert choice which uses AHP. . . . (Dr. J Interview 2, 12/14/06)

From the statements above, I was able to identify the sequence of activities (the flow) for each course topic discussed in Dr. J’s course. First, he explained the course materials to his students; then, he presented real-world examples and simulations to his students to demonstrate the application of the course materials; and finally he assigned homework that required students to apply the course material covered during that topic in class. When a new content area was covered the flow was repeated.

Dr. J’s espoused beliefs about his use of WebCT was consistent in both interviews as a means to actively connect students with his course objectives:

Obviously [WebCT provides access to] the lectures for the off-campus students, the streaming lectures, but I also use WebCT to post assignments, post handouts, and so forth. . . . I don’t use the discussion board; I have tried that in the past and no one
seemed to participate, right, so maybe if I had really poor participation issues [during the course], then I would try to really get them going [on the discussion board], but it seems that the on-campus students [aren’t] that interested. . . . I think the off-campus students want to do it, but the reason is that they are full-time working and they can do it on their own time, so each one of them have their own time when they can work in this kind of stuff. (Dr. J Interview 1, 11/13/06)

He stated that “[he doesn’t] think that [the off-campus students] have found the time to discuss these thing[s]” (Dr. J Interview 1, 11/13/06).

Dr. J said in both interviews that he emailed students regularly, checked his email regularly, and received telephone calls from students about the course materials. These findings were consistent throughout the on- and off-campus student interviews. He stated that emailing works both ways:

That is I am emailing information, making announcements, and so forth and then I get a lot of email questions, frequently I like to sit there and type the entire answer, so I sometimes email [the student] back and [tell] them to call me . . . I get a lot of telephone calls too. (Dr. J Interview 1, 11/13/06)

He emailed his entire class about course materials he posted online, but not about new lectures posted to the course, he assumed the students would “check and see if there [were new] lecture[s] posted” (Dr. J Interview 2, 12/14/06). He also stated during the interview that he emailed his students if there were specific instructions that he did not discuss in class:
[I sent] them an email before the final exam and talk[ed] to them a little, because they did not know that I was going to do this [multiple choice on the front of the exam] . . . so I wanted to make sure that they knew that the first five exam questions [the students] have to do on the front of the exam itself . . . the rest of them you do on the exam, but you have to put them back here because this is the only place that I am going to look [Dr. J was pointing at the front of the exam during the interview].

In summary, Dr. J espoused a variety of methods that students used to contact him in order to understand the course materials if they were unclear about the concepts or assessments.

**Approaches to Teaching**

Dr. J explained that his approaches to teaching had evolved with the advancements in technology, stating:

> It probably wasn’t so much a pointed effort to make changes it just kind of evolved, cause technology has changed and so forth . . . so I did some teaching . . . when I started, PowerPoint didn’t exist . . . so, part of my changes go along with the changes in technology . . . It was available and I thought, oh, that will work, so I would use it. (Dr. J Interview 1, 11/13/06)

He had attended a few educational sessions to improve his approaches to teaching and noted that the sessions aimed to describe different methods of teaching, such as developing materials during class to connect students with the content matter. He discussed how he used to use:

> …an overhead projector and put the problem on it and I also had a handout and I would say work on it and when someone gets the answer let me know . . . and then
[they] would talk about the answer and so forth. . . . That is what you would call interactive learning. (Dr. J Interview 1, 11/13/06)

Dr. J affirmed that he had tried that method of “interactive learning” in other classes but did not use it in this course. He did, however, discuss how he presented the materials in this class: “When I present material I try to, like here are the basics and here is how you use those and then keep building on that” (Dr. J Interview 1, 11/13/06). This was consistent with the flow of the course described earlier.

Dr. J espoused that there was no other way to teach the course “with 90% of your students watching you at a distance…especially in this class it is hard to get much interaction, so you have to be kind of a lecturer” (Dr. J Interview 2, 12/14/06). In addition, he used student feedback as a means for improving student interaction with the course materials and to learn from students in the field. The feedback came by emails “from students that say, oh, I found this paper based on something you talked about” (Dr. J Interview 2, 12/14/06). For example, he:

…presented some material on risk and a student emailed [him] and said, “well, I really felt like you left this out,” so I brought [in the material] and I included it in the presentation. . . . I will certainly be the last one to say that I know it all ‘cause, I don’t, especially with the students out there, I mean they have 20–25 years of experience. . . . I try to learn from students. (Dr. J Interview 2, 12/14/06)

Dr. J also described how he would print out a list of the class, in random order, and whenever he would ask a question he would call the next name out on the list. He stated, “sometimes that works, sometimes it doesn’t.” He noted that “I always ask [students] if
they have questions, but even if they have questions they don’t ask. . . . It becomes obvious later when they are doing homework or when they take an exam that they should have asked” (Dr. J Interview 2, 12/14/06).

From my perspective, Dr. J’s espoused beliefs on his approaches to teaching guided him through his course teachings and the course assignments (Researcher notes, 11/14/06, 12/14/06; Fall 2006 Course Syllabus; please also see Table 3.3 for the Course Key Events). There were also many technologies used that helped Dr. J enhance his approaches to teaching.

Dr. J stated consistently in both interviews that that biggest change in the last 20 years was PowerPoint and the ability to project it onto a screen for others to view. When he started his graduate studies there was only word processing, “but it was dedicated . . . it kind of looked like a desktop, but that was all it was, a word processor . . . so that has kind of evolved how you use Word to make handouts and PowerPoint to put lectures together” (Dr. J Interview 1, 11/13/06). He also stated that “the other thing would be, not just PowerPoint, but . . . a lab so you can actually do the stuff while you are talking about it” (Dr. J Interview 2, 12/14/06). Dr. J did not have a lab component accompanying this course.

Dr. J and I discussed the lack of off-campus student interaction in the class. He stated, “I could see a huge benefit and there are ways to do it, but it just is not handy yet…to be able to have real time interaction with all of the off-campus students.” (Dr. J Interview 2, 12/14/06). There were no assignments involving real-time participation during the course.
Approaches to Learning

Dr. J stated that his approach to learning changed as he moved into his graduate studies (e.g., studied to understand the material, instead of studying to pass a test). He espoused that

…it was interesting, I remember as an undergraduate, I was probably the same as most undergrads, you look at the materials to pass the test . . . and after passing the first few courses…I did okay, but when I came to [this midwestern university] to get my master’s degree . . . my study was totally different, I studied, when I studied, I tried to learn the material and understand it and then I did not have to worry about the exams. (Dr. J Interview 1, 11/13/06)

He affirmed that, “my approach changed from…memorization to more really sit down with this and try and understand and I can remember this especially in physics, sitting there trying to understand what some of those concepts meant and how they worked (Dr. J Interview 1, 11/13/06): “If I tried something I would read it to understand it” (Dr. J Interview 2, 12/14/06).

Dr. J stated that he reads many journals and tries to keep up with the “newer items in my particular subject area” (Dr. J Interview 2, 12/14/06). He also affirmed that he is “willing to listen and learn from others . . . don’t think that you know it all . . . and be willing to accept recommendations from somebody else or something that you should take a look at.” He stated that “a lot of learning is by doing . . . by applying things and seeing what happens” (Dr. J Interview 2, 12/14/06). Four (two on campus and two off campus) out of the seven student interview responses addressing Dr. J’s approaches to learning were
consistent with Dr. J’s espoused beliefs about his approaches to learning. The students addressed how he: had a rich background, worked through problems, read to learn new materials, made sense of the materials, studied examples, applied materials to the real-world, researched to learn new materials, wrote on the topic to learn more about the topic, and learned by doing (Off5 Interview, 11/15/06; OnSC1 Interview, 11/14/06; Off4 Interview, 11/14/06; On1 Interview, 11/30/06). One on-campus student stated that Dr. J’s approaches to learning echoed a lot of what engineering students want to do as well (On1 Interview, 11/30/06).

Dr. J stated consistently in both interviews that there has been more information made available than “when I started back in [1988]” (Dr. J Interview 2, 12/14/06). He also described that the web, specifically Google, has made it easier for him to find things:

You don’t have to go to the library necessarily to get a paper . . . you can just sit in your office and download it and print it out, so it certainly enhanced things and it is just amazing what computers have done . . . just the ability to do things, to try things, to play with things, and I always enjoyed programming so it was always fun for me to if I have it, like in my research it has to do with optimization, so this technology has allowed me to do a lot more with that. . . . I mean, I would use the blackboard, but now you can build a computer program to do the optimization algorithm and you can do different things with it, you can play with it more, you can do a lot more things more quickly, and evaluate a lot more things. (Dr. J Interview 1, 11/13/06)
Two students affirmed that Dr. J keeps up with the changing technologies by doing a lot of online research using the Internet and Google (On2 Interview, 11/30/06; Off1 Interview, 11/10/06). One of the students stated that she “would think that [Dr. J] would have learned [applications he brought to class] by studying them, by reading about them. . . . If there was a new piece I think he would just take his time to learn and apply that one as well” (On1 Interview, 11/14/06).

Dr. J concluded this section of the interview by stating that the “Internet did not exist when he started. . . . The first computer had what, two floppy drives . . . and there were no hard drives, so you know just the changes there. . . . It has certainly enhanced how you teach and how you learn” (Dr. J Interview 2, 12/14/06).

In summary, Dr. J’s espoused beliefs on his approaches to learning informed his approaches to teaching. I also identified that his approaches to learning were apparent to the students. In addition he used technologies that helped him enhance his approaches to learning.

Desired Learning Outcomes of the Course

Dr. J espoused some of his teaching beliefs about the desired learning outcomes of his course during the interviews. These beliefs were consistent in both interviews (initial and final) and his students’ interviews (5 off-campus, 2 on-campus). He stated that:

…the big one would be because hopefully by now they understand the systems engineering process, the outcome would be that when they are part of a design, I mean the whole idea is that you are designing this whole complex system, but when you are part of that that . . . you understand the things that you have to do early on
so that when you get farther into the project you are less likely to have problems and have to back up . . . basically you are more successful, not only the design is more useful, but it costs less, it is more reliable, that there is less risk involved, etc.

(Dr. J Interview 1, 11/13/06)

He also affirmed that students would not be “able to apply the systems engineering process because that takes experience” (Dr. J Interview 2, 12/14/06); instead he believed his students met the objectives for his course if they were able to:

…at least on a small scale . . . go out and then use the knowledge and the process they have learned and the tools that we have talked about in the class . . . and with others with experience, learn how to best apply the process and the tools . . . in order to design something . . . so ultimately they are going to be able to be designing. (Dr. J Interview 2, 12/14/06)

This answer helped me identify Dr. J’s espoused beliefs about his desired learning outcomes for his course. He stated that he believed students met the objectives for his course if they were able to apply the materials learned in class with others to do design. One student affirmed that Dr. J “would expect us to really apply what we have learned from class to real life problems” (On1 Interview, 11/14/06).

Dr. J used a variety of technologies to help him achieve the desired learning outcomes of his course. He stated that PowerPoint helped him achieve the desired learning outcomes of his course, because “in general, it just makes it easier to deliver it . . . to pass the knowledge on to someone else . . . makes it easier to do” (Dr. J Interview 1, 11/13/06). I identified PowerPoint as being the most important technology used in Dr. J’s course
according to the answers to the interview questions (as described in *Course Objectives* above).

Dr. J also discussed software used in his class, espousing that “using the different software, you force them to apply what we learn in the classroom to maybe a makeup problem, but still you are trying to get them from a small level, small scale, to start to apply it” (Dr. J Interview 2, 12/14/06). It was also apparent to me that he used many technologies in his classroom to enhance his learning and teaching, according to the answers to his interview responses.

**Two Contrasting Projects or Papers**

Dr. J stated in both interviews that the students do a research paper that is “the project for the semester for this class” (Dr. J Interview 2, 12/14/06). He expressed that he was unable to discuss specific examples of student’s contrasting papers, therefore he focused on describing, in general, contrasting examples of the quality and content of the research papers. He stated:

First of all there is a wide range of writing abilities, some of them do not have a clue what a paper should look like and then you read the paper and it is so disjointed and it is very hard to read . . . things are bouncing together and are not really connected . . . and then you have students that write and it is just cake to read. . . . So from a quality point there is a definite contrast . . . and obviously there are those that you can tell put a lot of time and those who wrote it the night before. (Dr. J Interview 1, 11/13/06)

He expressed that:
…the real intent is for them, not to just regurgitate back to me the stuff we already talked about in class . . . and I get that . . . and I will have some references, you know outside of the ones I have already talked about, but basically what they, like the paper I just read last night, I placed a comment on it that stated that I would have liked him to expand more beyond what we had talked about in class . . . and then I will see the other side, or the other extreme, which is much better, where it is completely . . . it is not unrelated to what we have talked about in class . . . . but, they had to really go out and dig and find resources and that is the intent of the project, it is exactly that . . . it is to make them go find, you know, learn something on their own. (Dr. J Interview 2, 12/14/06)

He also stated that you have those that are in between the two extremes. Another contrast identified by Dr. J was the content in the students’ papers. He said that some of the students “do a really good job, they summarize it really well and they learn something, but the other spectrum is sometimes I will let them take something I taught in the class and develop a case study where they are applying to something” (Dr. J Interview 1, 11/13/06).

Dr. J did not have any progress checks throughout the semester to evaluate students’ work on their papers. He required them to submit their paper topics by the second week of class for his approval, and he did not see the students’ work until they submitted the paper at the end of the semester (Dr. J Interview 2, 12/14/06). He stated that he could not make enough time to evaluate what 75 students were doing “two to three times throughout the semester” (Dr. J Interview 2, 12/14/06).
Are the Projects or Papers Different for Off-Campus Students?

Dr. J said in both interviews that the students with the most experience develop the best papers. He explained that experienced off-campus students may score a little higher (on exams and the research paper) because they may have a better handle on the material, although some of the off-campus students may be brand new to the field, so they may not have as good of a handle on the material (Dr. J Interview 1, 11/13/06). He also stated that there was no real difference between on and off-campus students’ papers because it depended on their level of experience with systems engineering and their writing ability (Dr. J Interview 2, 12/14/06).

Dr. J’s Teaching, Including His Use of Technology

This section introduces Dr. J’s teaching, including his use of teaching. Below I provide evidence from eight observed classroom lectures in order to identify Dr. J’s teaching, including his use of technology.

Classroom Observations

The classroom observations are described below using various voices (multiple perspectives) as a way to triangulate different data sets. The multiple perspectives communicate a deeper understanding of the professor’s observed classroom practices, including the use of technology. The voices are mine, as an observer of Dr. J’s classroom practices during real-time lectures; the on-campus students who participated in a focus group; and the off-campus student who participated in a telephone interview and answered the same questions that Dr. J answered in his interviews. Course materials and documents
(streaming lectures, WebCT, course outline, etc.) were also used to analyze observational data.

Eight of Dr. J’s lectures were observed in an EDE technology-equipped classroom. I was interested in observing these eight lectures because Dr. J stated that I would not only be observing the presentation of course information, but also the quantitative aspects of his course. I would be able to hear the information, see simulations and examples, and learn how to apply the fundamentals to real-world design processes. The flow of each of the lectures was consistent with Dr. J’s statements described earlier.

All eight lectures were similar in that Dr. J presented course information to the students, showed examples and simulations of the information being presented, and assigned homework after each specific course topic to make sure that his students understood the course materials. Throughout the observations, I (as an EDE staff member) helped the professor upload his lecture notes before some of his courses, troubleshoot technology problems during the courses, and communicated information to the EDE staff members for Dr. J when evaluation information needed to be disseminated to all the off-campus students.

Because Dr. J said that at the beginning of the semester I would be able to view the qualitative information presented. I reviewed the first few lectures using archived streaming media: I verified that Dr. J used PowerPoint to present large amounts of course information to his students. The flow of Dr. J’s lectures, described earlier, was consistent with two of Dr. J’s off-campus students’ interview responses. One of these students stated:
It seems like the first half of the semester the material was very qualitative, so he was showing us this graph from some sources and just kind of speaking to that and then moving on to the next thing and speaking to that . . . whereas, the second half has been more of “here is a mathematical method of how to analyze this data . . . I will show you an example, we will work through it on the board here in class, and I will even give you some other examples and post them on WebCT.” . . . It just seemed like there was a distinct split right through the course. (Off4 Interview, 11/14/06)

The other off-campus student stated that “the beginning of the course was mostly subjective material . . . and now we are getting into more calculative type stuff” (Off1 Interview, 11/10/06).

Lecture 1: 11/07/06. For the first observed lecture (Lecture 1, 11/07/06), Dr. J brought his lecture PowerPoint on a pen drive to upload to the instructor PC in the EDE technology-equipped classroom. At the same time Dr. J’s student producer turned on the microphone, started the projector, lowered the projection screen, turned on the Smartboard to project the course information, started recording the Tablet PC screen with Camtasia (hi-rez recording of instructor audio and Tablet PC screen that is edited by EDE staff after the lecture concludes and is then uploaded to WebCT), prepared the introduction slides, and cued the introduction music. When Dr. J was ready to begin the class he spoke into the microphone so his student producer would know that he was ready to begin. His student producer followed the same intro and exiting sequence as described in Chapter 3. Dr. J
knew to begin his lecture once he saw himself on the television located in front of him. This was a typical process that occurred before and after all of Dr. J’s lecture sessions.

Dr. J told his students that his intentions for this lecture were to discuss different functions, methods, and tools to help them understand the materials. He stated the objectives at the beginning of the lecture, which were:

- To discuss cumulative distribution function (CDF),
- To discuss inverse transform method, and
- To discuss triangular distribution (Researcher notes, 11/07/06)

From my perspective, I believed that Dr. J wanted the students to think about the course materials and try to understand them (Dr. J gave many examples to help students understand the materials); he asked the students many different questions throughout the lecture to see if they understood the materials, although some students did not clearly understand the materials that Dr. J was covering. Dr. J also gave other examples to help clarify the material; he gave different examples until the students nodded and acted as though they understood the material.

During the lecture, I observed that Dr. J’s students asked and answered questions. If the students had a hard time answering the question, then he would ask the question in a different way or another student would address the same question in order to understand the answer to the question. I observed that Dr. J would not move on to another concept until the students seemed as though they understood the materials. During the on-campus student interview, one student stated that Dr. J “makes sure that everyone has the answer to
their questions, he is very careful about that”. From this student’s perspective, Dr. J “visualizes everything to make it clear” (On1 Interview, 11/14/06).

I observed that students brought along course lecture notes to class to follow along with the lecture; Dr. J stated in the interviews that he posted lecture notes beforehand so that his students could download them and follow along with the lecture. Two on-campus students affirmed that Dr. J “instantly gets a lot of stuff right there to the web either beforehand, so the students can have the materials before they come to class or right after the class with the annotations from class . . . it is really nice to have his notes and the ones he handwrites too” (On 2 Interview, 11/30/06). Another on-campus stated that “because you come prepared and I think it helps with your concentration time, you have the basic idea, so you are somewhat prepared with what you will be learning, it helps” (On1 Interview, 11/14/06).

I observed that Dr. J scaffolded his students’ learning in many ways throughout the course. He gave his students step-by-step information about the course materials. He gave his students advice to print out the annotated notes and compare them to the archived lectures in order to improve their understanding of the material covered during lecture, and he repeated specific materials at least three times during the lecture (Researcher notes, 11/7/06). I asked Dr. J why he repeated the materials and he stated that he repeated them so that his students would know how important the material was for them to understand for future assignments, for the exam, or for application in future real-world environments. He also stated to the students that they should access WebCT in order to obtain and complete their homework assignments that were the next lecture session (Researcher notes, 11/7/06).
I observed that Dr. J employed a lecture-based technique throughout the lecture by sitting or walking around in front of the class presenting information to his students. This was consistent with student interviews. One student stated:

Until now it has been lecture delivery with a little bit of questions so that his on site students are active and listening to him, but mostly it has been lecture delivery. . . . He knows his stuff. . . . His background and his experiences have involved systems engineering and other applications so he takes these into account and refers back to them. (Off2 Interview, 11/13/06)

Another student confirmed that, “a lot of class…is a lot of times him teaching with the occasional students asking questions” (On2 Interview, 11/30/06). The response of a third student was consistent with the statements above, but he also noted that “if [Dr. J] stops and asks questions . . . you know if we had a roundtable discussion on each and everything, then we would not get anywhere” because he has a “large amount of information to cover” (Off4 Interview, 11/14/06).

Dr. J used multiple technologies to help him deliver his course materials. He utilized the Whiteboard to present information, complete equations, and define terms. One student stated that “he like[s] . . . how [Dr. J] presents [using the whiteboard]” (Off5 Interview, 11/15/06). From that student’s perspective, professors write better on the whiteboard than using the Tablet PC (described later), although he stated during the interview that he did have a hard time viewing the whiteboard when the professor walked in front of the material; he stated that he would pause the streaming lecture on the material
so that he could write it down before Dr. J walked in front of the camera (Off5 Interview, 11/15/06).

Dr. J used the instructor PC to demonstrate examples and test simulations, including Excel. From one student’s perspective, “[Dr. J] might use a basic Excel spreadsheet to help demonstrate some of the problems he is using” (Off4 Interview, 11/14/06). Dr. J also used the Tablet PC to present his PowerPoints, including course information and screen shots of Excel so students could see the step-by-step process more clearly. Dr. J’s students stated consistently during the interview that they liked how he used PowerPoint in the classroom. One student described that:

…when it comes to technology, this course is really great because you can see . . . a computer screen and a . . . [PowerPoint] slide show. . . . I think, it improves your understanding of what is going on . . . and also following the lectures from WebCT we have all the lectures just before the lecture time and we can be prepared by taking our [PowerPoint] handouts, we can just put notes to our handouts during, while listening to the course . . . and once we are out of lecture we have our notes, his notes, and everything is in order. (On1 Interview, 11/14/06)

Dr. J also used the overhead camera to show students information directly from the required textbook. According to the syllabus of this course (accessed from WebCT, 11/7/06), the students had a textbook and additional papers as required readings as well as specific material that was not in the textbook or the papers provided.
Dr. J’s on- and off-campus students stated consistently throughout each interview that his use of technology in his approaches to teaching helped enhance their understanding of the material. One student stated that Dr. J:

…uses graphics and he visualizes everything to make it clear and easy for us to understand . . . and when he needs something from the book he just organizes it so with no time lost, he brings it in himself . . . it is not required but he brings it in and shows it under the overhead camera . . . for example, an appendix to show or there was this special table to show . . . he does that. (On1 Interview, 11/14/06)

Another student affirmed that Dr. J was “pretty practical…whatever he needs to use to demonstrate it and make it applicable to what you might have to do in the real world . . . not everybody does that” (Off5 Interview, 11/15/06). This was consistent with the interview response of a third student, who indicated that Dr. J’s use of streaming has been very helpful for him, because he can “pause it, rewind it, and re-watch the whole lecture if I want” (Off4 Interview, 11/14/06).

During this lecture, Dr. J directed his student producer to move from technology to technology in order for her to capture the appropriate material being discussed. If the student producer was capturing the wrong information, then Dr. J would speak into the microphone and direct his student producer to capture the correct material. One student stated that “Dr. J’s class is normally very good . . . it is in other classes where it is not as good. . . . I would say that just Dr. J does a pretty good job . . . he works with the student producers pretty good and…he must be able to watch what he is doing” (Off5 Interview, 11/15/06). This was a typical process that occurred during each of Dr. J’s lecture sessions.
Lecture 2: 11/09/06. During lecture 2, Dr. J stated that his intentions were to finish chapter 8 and move on to chapter 9 in their textbook. He did not state his objectives for the course in an organized fashion at the beginning of the lecture, but I observed that he described his course objectives before starting a new concept during the lecture session. He stated that his objectives for this lecture were to finish up Monte Carlo simulation, move on to engineering economy, and then towards the end of class he gave the students a brief introduction to response surface methodology (RSM) and stated that he would fully cover this concept in the next lecture session.

I observed that Dr. J began this lecture by using the whiteboard to finish the discussion about Monte Carlo. Students asked two questions about Monte Carlo and he responded to the questions with answers and examples to demonstrate and discuss the materials. He asked the students if they had used Monte Carlo simulation before, and some of his students addressed how they used Monte Carlo simulations in their own work, including different software applications used to do these simulations. After they finished discussing Monte Carlo simulations they moved on to discuss engineering economy.

Dr. J used the Tablet PC to demonstrate screen shots of the Excel program and then moved over to the instructor PC to run the examples and create histograms. He proceeded to show examples and move back and forth between the instructor PC and the Tablet PC demonstrating about seven examples during this lecture. A few of the students did not know that they were going to cover engineering economy in such detail, and one student stated, “I wasn’t expecting the engineering economy” (Off3 Interview, 11/10/06), whereas another student response indicated that “some of the engineering economics, I really didn’t
know we were going to go into that much detail, as much as he did . . . although, I had taken as an undergraduate engineering economics, so I wasn’t in complete shock” (On2 Interview, 11/30/06). A different student believed that the information Dr. J presented was applicable to practical applications, therefore he thought it was necessary to cover the concepts. This student affirmed that “he picks the most applicable thing, like we did the engineering economy stuff and you had to make sure to pick the right approach to a problem and not to really touch on everything” (Off5 Interview, 11/15/06).

I observed that Dr. J linked the content of the lecture to the content in their book and asked questions after he addressed a concept or before he began a new one. He also identified that there was some information in the lecture that was not covered in their textbook as well as errors in the textbook to document. He also addressed all the students about the book readings. He addressed the off-campus students directly about the readings by speaking directly into the camera in front of him in order for the off-campus students to know that he was speaking directly to them. Dr. J also stated to all students in the class that their homework assignment involving Excel was posted on WebCT.

During this lecture, Dr. J mentioned many times to students about contacting him if they had any questions about the homework assignments or other course materials: I observed that there was a lack of student discussion during the lecture session (this was consistent during each lecture). From one student’s perspective, there was not a need for much discussion because the homework assignments were not very difficult: “I have either been able to figure it out on my own or I can do some digging around, or I can ask [Dr. J]”
Two other students affirmed that they did not have to initiate any teamwork during the lecture sessions; one stated that:

…she did not initiate any teamwork during this course . . . because . . . everything was so tidy and proper. I did not even have to ask [Dr. J] anything. The lectures were clear and explanatory, [and] all [of the] notes were available on WebCT. (On1 Interview, 11/14/06)

Two off-campus students noted that communicating with their peers would have been helpful. One stated that the course “probably would be easier if I had people to bounce things off of in class, but [Dr. J] has been really good helping me in that respect” (Off3 Interview, 11/10/06).

Dr. J stated about three times during the lecture that if students had questions that they could contact him via email, call him at his office, or come to his office to discuss their questions. From two students’ perspectives, Dr. J’s willingness to extend further support outside of class time was apparent. One stated:

He does it all the time in lecture. You feel he is there for you to help you more! He wants to help you with your learning, because he always mentions him being in the office all the time, that we can email him anytime and when you email him he is really there and when you call him he is really there. (On1 Interview, 11/14/06)

This response was consistent with another student’s response: “[The students] have the freedom to give [Dr. J] a call or an email later to ask him questions and he always tells us sometimes that he available in his office and that we can call him” (Off2 Interview, 11/13/06).
Lecture 3: 11-14-06. During the beginning of lecture 3, I [as an EDE staff member] helped Dr. J transfer his PowerPoint from his pen drive to the Tablet PC. He could not find the Tablet PC pen and was becoming a little bit frustrated, so his student producer found a new pen and I helped so that the class would begin on time. I [as an EDE staff member] printed his PowerPoint to Windows Journal Notes in order for him to be able to annotate on them using the Tablet PC.

Dr. J stated that the intentions for this lecture were to discuss simulations and give examples of those simulations (Researcher notes, 11/14/06). His objectives were discussed throughout the lecture session, as was reported for Lecture 2. The objectives for this lecture were to discuss the reality of the system; to discuss models, such as the regression model, and finding optimal solutions (heuristics); and to understand the closed loop asynchronous automatic assembly system in order to minimize cost per unit, but at the same time meet demand. I observed that when Dr. J discussed how to find the optimal solution, he referred to aspects from the previous lecture in order to help the students connect with the various concepts. From my perspective, Dr. J presented a wide variety of examples during this lecture (approximately six examples), although no simulations were brought into class to demonstrate to the students.

Dr. J used the same technologies as in the first two lecture sessions: the whiteboard to present information and work through equations, the Tablet PC to present screen shots of up-close, step-by-step software applications, and the instructor PC to present other information and examples to his students. One student affirmed that Dr. J kept things “pretty basic . . . we use Excel and he has shown us a couple tool, industry tools in class,
but other than that it is just basic PowerPoint lecture approach” (Off4 Interview, 11/14/06). Another student expressed that:

[Dr. J] gives us information about the technologies and possible technologies out there that we can use and he . . . shows us them and tells us about them, so once we face such problems then we can . . . use it in a simulation or something that will help us solve the problem. (On1 Interview, 11/14/06)

According to the interview responses of three of Dr. J’s students (one on campus and 2 off campus), the streaming media and WebCT were the most important elements of this course. One student stated that he “would not have been able to take the course . . . if I couldn’t actually see the lectures” (Off1 Interview, 11/10/06).

Dr. J’s students took notes as he proceeded with the course, presenting information and demonstrating examples. I observed that Dr. J used prepared notes to help him keep on track during the lecture session: I asked Dr. J after class if the notes he used in class were pre-existing and he stated that they were and that they helped him with the flow of his lectures (Researcher notes, 11/14/06).

Dr. J asked the students questions after each concept addressed during this lecture. He asked the students if they had seen any simulations or examples in their work or study; he specifically addressed that he was interested to learn if off-campus students were using these simulations (Researcher notes, 11/14/06). One of his students said that she had used a certain application in her work. I observed that she made sure to press down the microphone in front of her (standard in two EDE technologically-equipped classrooms), so that off-campus would hear her when they watched the stream or downloaded the lecture.
From one student’s perspective, Dr. J asked the students a lot of questions during lecture, although students might not have replied. The student expressed that this could be because:

…it is 8 o’clock in the morning . . . not a lot of people usually respond. . . .

Sometimes I have noticed that especially in the technology classes that for some reason students . . . it is the hesitation of using the microphone . . . because they know that it is going to be recorded . . . and zoom in on them. (On1 Interview, 11/30/06)

I observed that four students asked Dr. J questions during this lecture: Dr. J responded to their questions with examples or further explanations in order to help them understand the concept of the simulations (Researcher notes, 11/14/06). When the lecture session was coming to a close, around 9:10 am, Dr. J’s students asked him if they could see a simulation of the examples he had shown during the lecture. He stated that they could come to his office to see an actual simulation because the software was not on the instructor PC in the technologically equipped classroom. No students reportedly went to his office to view simulations (Researcher notes, 11/14/06).

Lecture 4: 11-16-06. During lecture 4, Dr. J stated that the intentions were to show his students a simulation, to address any questions to clarify their understanding, and to discuss other methods, such as RSM, stochastic “quasi-gradient” method (SQG). He did not state his objectives for the course in an organized fashion at the beginning of the lecture, but I observed that he described his course objectives before starting a new concept during the lecture session. Dr. J stated that the objectives for this lecture were to
demonstrate a steady state simulation software (ARENA) that was discussed in the previous lecture and to have his students understand project scheduling and optimization.

I observed that Dr. J brought a piece of software that he developed to demonstrate to the students in order for the students to “see” the simulation and ask questions if they were unclear of the processes. He used the instructor PC to demonstrate the simulation and then asked his students questions. Both he and his students asked questions about the simulation (about four questions were addressed); one question that Dr. J asked was answered wrong by the student, so he said that the student had a 50/50 chance at answering correctly and then addressed why the answer was not correct. I observed that two other students participated in a discussion about simulation software with Dr. J in order to clarify the answer to one student’s question; this question was not clearly described by the student, so another student joined the conversation because he/she felt as though he/she understood what the student was asking and could clearly define the question for Dr. J.

Dr. J used different methods and technologies throughout his lecture. He used the whiteboard during the lecture to write out equations and present different methods. I observed that he used his prepared notes to help guide him throughout the lecture (Researcher notes, 11/16/06). Dr. J also used the Tablet PC to present examples of the simulation software and information about different methods. When he began using the Tablet PC he could not locate the mouse, so his student producer spoke into the classroom microphone and directed Dr. J to the mouse that was charging behind the instructor PC. He found the mouse and proceeded with his lecture.
From my perspective, Dr. J tried many different ways to demonstrate the simulation and equations to clearly describe the concepts to the students in order for them to understand the whole process. For example, he linked the current lecture with the previous lecture when discussing the iterative process to find the “optimal” solution. He also tried to capture his students’ interest in the simulations by stating during the lecture that, “the annealing process was fun to play with and powerful” (Researcher notes, 11/16/06).

Lecture 5: 11-28-06. Dr. J stated that the intentions for this lecture were to complete coverage of optimization and to begin discussing project scheduling, which is discussed in further detail in the subsequent course (Researcher notes, 11/28/06). He did not state his course objectives at the beginning of the lecture; instead he stated the objectives before moving on to a new concept during the lecture. He stated that his objectives for this lecture were: to describe genetic algorithms by explaining them, demonstrating them, and discussing them; to describe crossover; to discuss tabu searches after they were done with optimization; and then to conclude with project scheduling. He stated at the end of this lecture that he would start the next lecture with an example of project scheduling.

Dr. J used the same technologies that were used in the previous lectures to deliver his course materials. He used the Tablet PC to present his PowerPoint lecture. I observed that on each slide he had information or illustrations about different concepts. In order to clearly explain the material to his students he would illustrate the information on the Tablet PC, then he used the whiteboard to explain and demonstrate equations and situations that were illustrated using the Tablet PC. For example, Dr. J presented the students with a code, a good code, that he had developed. He discussed the code and then stated that the students
could have access to the code if they wanted to work with it at a later date (Researcher notes, 11/28/06). He moved from the Tablet PC to the whiteboard seven times during the lecture. From one student’s perspective, there were limitations to using the Tablet PC and the whiteboard in the lectures; he stated that:

…the Tablet work pretty good . . . the only thing . . . the downside of the Tablet . . .

I think that when Dr. J uses it, and other professors use it, that they have a hard time writing on it vs. writing on the whiteboard . . . like on the regular whiteboard they always do a better job writing there, but then they write so big, so you go to WebCT and to view it you have to zoom into it and it gets tricky. (Off5 Interview, 11/15/06)

From my perspective, Dr. J used different methods, tools, and techniques in order to help him teach his students to understand the materials more clearly. He repeated important information at least three times during the lecture (as seen in previous lectures). He covered aspects beyond the textbook (e.g., the lack of resource constraints) during the lecture so his students would have information they might otherwise be without. He also expressed interest in the topics he presented to his students: He told them how fun and neat the examples were to play with and the need for them, so he made sure to show his students real-world examples in lecture (Researcher notes, 11/28/06). One student affirmed that Dr. J explained:

…the theory not kind of super detailed, but enough that you understand what is supposed to be happening and he does do examples to kind of show how you might use the different techniques or different theories that he is presenting . . . he does a pretty good job with that . . . I mean he does not do too much theory and not enough
examples . . . or a lot of examples and no theories behind why he is doing it . . . he seems to mix that up pretty good! (Off5 Interview, 11/15/06)

Another student stated that “he is seasoned so he gives a lot of examples, real-life examples, during class” (Off1 Interview, 11/10/06), which was consistent with what two other students expressed. One student stated:

[Dr. J] actually uses real-life examples, which really helps, during lecture. I think he has experienced systems engineering in the professional field, so it really becomes interesting when he gives us examples of what he has done. He normally does this with things he is covering . . . methods we are discussing . . . he just clarifies things with examples and sometimes the concept is a little complicated . . . he makes sure that everyone has the answer to their questions, he is very careful about that. (On1 11/14/06)

From my perspective it was apparent that Dr. J’s students understood the flow of his course and the reasons for which he presented specific course materials.

Dr. J asked his students’ questions during the lecture after each concept and simulation was discussed and before moving on to a new concept or simulation. One question that was asked at 8:25 am did not receive any student responses, so he asked the students in a different way, which elicited a response from one student. He also described the course concepts clearly and in great detail to his students: He showed the students how to do certain things with the concepts, what not to do, and what they will and will not have to know about the concepts.
From my perspective Dr. J included multiple perspectives into the course to improve student understanding. During this lecture he described a book about algorithms that he thought would help enhance his students’ understanding of the content material. He stated that the book would help his students learn more about algorithms in order to understand them clearly (Researcher notes, 11/28/06). He also gave examples from a master’s thesis, completed at this university, in order to present real-world applications and findings.

*Lecture 6: 11-30-06.* During lecture 6, Dr. J stated that his intentions were to discuss project scheduling and critical path method (CPM). He did not state his objectives for the course in an organized fashion at the beginning of the lecture, which was consistent with the observations from the previous lecture. Dr. J stated that the objectives for this lecture were to demonstrate examples of CPM, to cover Microsoft Project in order to create a Gantt chart, and to explain heuristics (covered in previous lectures) and why it is important in systems engineering.

I observed that Dr. J used technologies to deliver his course materials. He used the Tablet PC to present information and show examples (as seen in previous lectures). If the information he needed to cover was not included in the PowerPoint on the Tablet PC, then he used the blue notes, which were 8½ x 11 pieces of blue paper captured by the overhead camera and projected and recorded. He directed his student producer to focus in on the overhead camera to clearly see the material on the blue notes, and then he had to tell her again to move to the Tablet if he changed to a different concept; he directed the student producer at least six times during this lecture (Researcher notes, 11/30/06). He used the
blue notes to present information and draw examples to clarify content material for his students.

During the lecture Dr. J drew an example of CPM on the blue notes, followed by lecture notes that were prepared on the blue paper: I asked him after class if the notes were made before the lecture and he agreed stating that they were made in the previous semesters (as observed in previous lectures, although they were not blue). The use of the blue notes was observed for the first time in this lecture (Researcher notes, 11/30/06).

From my perspective, Dr. J included various techniques to improve his students’ understanding of the course topics during the lecture. He explained to the students what he wanted them to know and what he preferred about the concept. He demonstrated examples by hand that were not included in the textbook, presented computer programs that would apply the information, and linked current class content with previous course handouts that the students already had access (Researcher notes, 11/30/06).

For example, Dr. J described to his students a personal example that he used while he was in the Air Force as a heuristic method. One student affirmed that Dr. J “tell[s] stories when he used to work at certain places” (Off3 Interview, 11/10/06) to help enhance his students’ understanding. Dr. J also gave students a problem in class to complete by the next lecture. He told the students that he would post the answers in a few days so that they could compare their answers, but he asked them to please do it on their own before looking at the answers (he repeated this three times during the lecture; Researcher notes, 11/30/06).

I observed that Dr. J asked his students questions during the lecture after each concept was discussed and before moving on to a new concept (as observed in the previous
lectures). One of these questions focused the attention of two students, including the student who first answered incorrectly and the student who followed up with the question and gave the correct response (this was observed twice during the lecture; Researcher notes, 11/30/06). It was also observed that his students asked questions during the lecture, which enabled him to present many different examples (as observed in previous lectures). He explained the examples, and then more students had questions. He told his students that it kept them thinking and then stated that he would bring in another program to present to them on the last day of class (Researcher notes, 11/30/06).

Lecture 7: 12-05-06. During lecture 7, Dr. J stated that his intentions were to clarify his students understanding of the examples and the course topics covered in the previous lecture (e.g., book keeping and heuristics; Researcher notes, 12/5/06)). He did not state his objectives for the course in an organized fashion at the beginning of the lecture, which was consistent with the observations from the previous semester. He stated that the objectives for this lecture were to discuss complex ambiguity functions (CAF) and program evaluation and review techniques (PERT). He also stated that the next time the class meets he will discuss the non-cumulative final exam and answer any questions the students may have about the current course materials (Researcher notes, 12/7/06).

From my perspective, Dr. J used the same technologies that were observed in the previous lectures. He drew examples on blue notes, presented information on the Tablet PC, and annotated on his PowerPoint about CAF. He directed his student producer to showcase specific information on the Tablet PC and the blue notes by changing the camera shot or zooming in on the course materials (as observed in previous lectures). He stated
During lecture that he would post the additional information from lecture (e.g., the annotated notes, blue notes) for the students to view at their own convenience (Researcher notes, 12/5/06). He then gave a brief history of PERT and described in detail what PERT was and what it does. He explained to his students that the book defines PERT a different way, but that they are to remember it the way he described it in lecture (Researcher notes, 12/5/06). Dr. J then demonstrated a Monte Carlo simulation using PERT to his students using the whiteboard.

From my perspective, Dr. J used different methods, tools, and techniques in order to help his students understand the materials clearly (as observed in previous lectures). He gave his students multiple examples of the course materials, asked many questions, described the topics in detail, addressed how the concepts would be used in the homework assignment, and answered student questions during the lecture (as observed in previous lectures). He also used the same prepared notes to guide him through the course materials (as observed in previous lectures).

Lecture 8: 12-07-06. At the beginning of the last lecture, Dr. J asked me, as an EDE staff member, to notify the EDE staff members to send out a course evaluation for off-campus students: After the course, I notified EDE staff and an email was sent out to all off-campus students. During the lecture, Dr. J stated that his intentions were to cover any topics that students were unclear about and to discuss the final exam and any questions relating to the final exam. There were no stated objectives for this lecture (Researcher notes, 12/7/06).
From my perspective, Dr. J used the same methods, tools, and techniques that were observed in the previous lectures. He first discussed a piece of software that he and a graduate student had developed (as promised in Lecture 6), which was actually used in the Air Force in Georgia. He then presented information on the Tablet PC with screen shots from the program so students could see the application more closely and follow along step-by-step through entering data into the program. As Dr. J described the screen shots, he moved over to the instructor PC to type the appropriate information into the required fields (he proceeded to do this until he showed students all the steps necessary for the simulation to work). He ran the simulation and discussed the input and output with the students using the Tablet PC (Researcher notes, 12/7/06). He then used his prepared notes to describe the answers on the whiteboard.

I observed that Dr. J asked his students questions before and after each concept discussed and responded to student questions about the course material during the lecture (as observed in previous lectures). He encouraged the students to play with simulation software and stated how fun it was to learn about and play with the software (Researcher notes, 12/7/06). One student responded to his comments by expressing how he used the simulation software in his work (Researcher notes, 12/7/06). Dr. J then stated that the students could access this lecture’s information from WebCT and that the answers to the question he posed a few lectures back were posted on WebCT for them to compare their answers (as promised in Lecture 6).

Toward the end of the lecture, Dr. J discussed the non-cumulative final exam with his students by using the whiteboard to present important exam information. He discussed
what would be on the test, what would not be on the test, and that the students were allowed to write notes to themselves on one side of an 8½” x 11” piece of notebook paper to use during the exam; the notebook paper prepared by the students was to be submitted with the final exam. Dr. J then excused the last lecture session of the semester.

The Second Case Study’s Findings

The main objective of this research investigation was to examine one faculty member’s espoused beliefs and his classroom practices using technology to see if there were any similarities or differences (the phenomenon) between his espoused beliefs and teaching practices using technology (Martin et al., 2000). The research question that guided this analysis was: How do an engineering faculty member’s espoused beliefs relate to his/her observed classroom practices using technology? In order to understand the phenomenon of Dr. J’s espoused beliefs and classroom practices using technology, I examined the similarities and differences between his espoused beliefs and his classroom practices. To support these findings, Dr. J’s espoused beliefs and classrooms practices were described in an exemplary vignette and then compared to Martin et al.’s findings from Dr. Davis. The section concludes with a summary of the findings.

*The Phenomenon of Dr. J’s Espoused Beliefs and His Classroom Practices Using Technology*

In order to explain the phenomenon, I followed Yin (2003) to “stipulate a presumed set of causal links” (p. 120) among all data collected and analyzed. These causal links enabled me to explain how one engineering faculty member’s espoused beliefs relate to (are similar to or different than) his observed classroom practices using technology, as
summarized in Table 5.4. Dr. J’s espoused beliefs and his observed classroom practices were very similar; there were no differences identified between his teaching approaches and the way in which he managed his course.

Dr. J used different teaching methods, tools, and techniques in his classroom in order to transmit all of the course information to his students. He taught his students in a way that enabled them to develop their own understanding of the materials. During the classroom observations, Dr. J used his expertise in the content in order to transmit all of the course information to his students, and he was a facilitator, in that he addressed the course content with multiple perspectives so students could develop their own understanding of the materials (Lecture 1, 11/07/06; Lecture 2, 11/09/06; Lecture 3, 11/14/06; Lecture 4, 11/16/06; Lecture 5, 11/28/06; Lecture 6, 11/30/06; Lecture 7, 12/05/06; and Lecture 8, 12/07/06).

Vignette of Dr. J

This section provides an exemplary vignette of the ways that Dr. J described his teaching beliefs and the relationship between his espoused beliefs and his approaches to teaching using technology (the outline was adopted and modified from what Martin et al., 2000, referred to as a vignette). The vignette includes the relationship between Dr. J’s espoused beliefs and classroom practices, including the use of technology, descriptions from his classroom observations, his approaches to teaching with technology, and his reflection on his own classroom practices. This vignette is a descriptive story of the relationship between Dr. J’s espoused beliefs and his classroom practices.
Table 5.4. Similarities and Differences (Causal Links) Between Dr. J’s Espoused Beliefs and Classroom Practices Using Technology

<table>
<thead>
<tr>
<th></th>
<th>Espoused beliefs</th>
<th>Classroom practices</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teaching approach</strong></td>
<td>Dr. J espoused a teacher-centered teaching approach, an approach where the teacher knows the concept area and transmits the information to students in the class.</td>
<td>Dr. J aimed for his students to understand the content material clearly by giving his students many different examples, asking many questions before and after each concept, and addressing student’s questions about the course materials. This way the students would be able to make connections with the information being presented in a way that was meaningful for them. I observed some student-centered approaches in the classroom, an approach where the students create their own understanding of the content material.</td>
<td>No differences</td>
</tr>
<tr>
<td><strong>Main objective</strong></td>
<td>To understand the fundamentals of systems engineering, including the basics, the tools, and methods to effectively design in a real-world setting.</td>
<td>To understand the fundamentals of systems engineering, including the basics, the tools, and methods to effectively design in a real-world setting.</td>
<td>No differences</td>
</tr>
<tr>
<td><strong>Course management</strong></td>
<td>As a facilitator and a content expert, Dr. J aimed for his students to understand the content material presented in the course.</td>
<td>As a facilitator and a content expert, Dr. J aimed for his students to understand the content material presented in the course.</td>
<td>No differences</td>
</tr>
</tbody>
</table>
| **Role of technology**               | • Technology as a tool for teaching  
• Course access (anytime and anywhere)  
• Present course information to the students in an organized fashion  
• Improve course delivery | • Technology as a tool for teaching  
• Course access (anytime and anywhere)  
• Present course information to the students in an organized fashion  
• Improve course delivery | No differences                        |
The relationships are described below using the following outline (adapted and modified from Martin et al., 2000, p. 398-400): What is it that you teach to your students?; what must your students know?; how will your students be brought into active connections with that knowledge?; Dr. J’s observed practice, Dr. J’s approaches to teaching with technology, and Dr. J’s reflection on his practices.

*What Is It That You Teach to Your Students?*

Dr. J described his intentions with his students during each of his observed lectures. His intentions were to describe what would be covered during the lectures; what students would need to understand for assessment purposes, specifically to understand course topics relating to systems engineering; and what has been done in the professional field in relation to systems engineering (see Classroom Observations above). Similarly, during the lectures, I identified Dr. J’s graduate course objectives. His objectives aimed to improve students understanding of the fundamentals of systems engineering in order to effectively design in a real-world environment with experienced professionals: He did not state specific objectives at the beginning of each lecture, but stated the objectives throughout the lecture as he moved on to new concepts (see Classroom Observations above). From my perspective, Dr. J’s intentions were to “engage the students with the elements of professional practice” (Martin et al., 2000, p. 393).

*What Must Your Students Know?*

Dr. J stated that his students must “understand the systems engineering process,” such as:
...the things that you have to do early on so that when you get farther into the project you are less likely to have problems and have to back up...basically you are more successful, not only the design is more useful, but it costs less, it is more reliable, that there is less risk involved. (Dr. J Interview 1, 11/13/06)

According to responses in both interviews, Dr. J’s intentions were to teach his students the knowledge necessary in order to learn the course materials successfully; that is, to have the students understand the fundamental theories and processes of systems engineering in relation to professional practice. In doing so, Dr. J expressed that his students would be able to develop and improve design with other experienced professionals in the field of systems engineering. From my perspective, Dr. J’s intentions were to “enable [his] students to learn the materials through practicing the discipline knowledge, engaging with the material in ways similar to that of the qualified practitioner” (Martin et al., 2000, p. 395).

How Will Your Students Be Brought into Active Connections with That Knowledge?

Dr. J discussed the sequence of activities (the flow) for the topics presented in his course during the second interview (see Students’ Active Connections with Course Objectives above): He explained the course materials to his students; then, he presented real-world examples and simulations to his students to demonstrate the application of the course materials; and finally he assigned homework that required students to apply course material covered during class. In both interviews, he stated that he gave his students’ homework assignments and exams during the course to reinforce the course materials.
Dr. J expressed that some students did not ask questions in lecture, so when he graded the homework and exams he was able to identify course concepts that were not fully understood by the students. He was able to identify what concepts needed to be explained further, using different tools and techniques, in order to help the students understand the course materials in a meaningful way. Dr. J also encouraged student interaction during and after the lectures. He asked his students questions, gave them examples of the course concepts, invited them to contact him outside of class time, and answered their questions about the concepts (see Classroom Observations above). From my perspective, he aimed to engage his students “in the practice of the discipline with the intention of helping students develop their conceptual understanding” (Martin et al. 2000, p. 395).

**Teacher’s Observed Practice**

Dr. J’s classroom approaches were observed from the eight lectures to be traditionally lecture-based. This was evident from how he sat behind or walked around the desk at the front of the classroom, face-to-face with all the students. He covered massive amounts of content materials presented to the students in a sequential order with the help of the whiteboard; the Tablet PC, including his PowerPoint slides; and blue note paper. He also used prepared notes and blue notes to help him guide the lectures (see Classroom Observations above).

Dr. J would also stop periodically in lecture, before and after he covered a course concept, to ask his students questions about the course material. For example, he asked the students a question during lecture 4 and waited for about 1 minute until students said something. If the something that the students said was not what he was aiming for, he
would go back and describe the information again using a different example or different explanation (Lecture 4, 11/16/06). Dr. J was very focused on having his students understand the fundamental elements of systems engineering.

**Teacher’s Approaches to Teaching with Technology**

From interview sessions with Dr. J, it was apparent that he was intrigued with the use of technology in his classrooms. He espoused beliefs that his approaches to teaching changed “with the changes of technology . . . it was available and I thought, oh, that will work, so I will use it” (Dr. J Interview 1, 11/13/06). He utilized many different technologies in his classroom to deliver the course materials to his students (see Classroom Observations above).

In his classroom, Dr. J used the whiteboard to present and discuss course concepts with his students; the Tablet PC, which included his PowerPoint presentations, to present up-close screen shots of simulation software so students could see them clearly and to annotate new notes discussed during the current lecture; and blue note paper to draw examples and discuss information about course materials. As a supplement to his classroom, Dr. J used WebCT to post class materials for the students, including the lecture notes (annotated) and the streaming lectures.

In order to notify his students of posted materials and other relevant course information, Dr. J emailed his students. He also encouraged his students to email, call, or come by his office, outside of class time, if they had any questions about the course materials. From my perspective, Dr. J focused on using technology as a tool to help him
deliver course materials to his students in order to improve their understanding of the course materials.

Teacher’s Reflection on Practice

Dr. J wanted his students to understand the fundamentals of systems engineering in this graduate class. He stated that he wanted his students to:

…go out [in the professional field] and then use the knowledge and the process they have learned and the tools that we have talked about in class . . . and with others with experience, learn how to best apply the process and the tools . . . in order to design something . . . so ultimately they are going to be able to be designing. (Dr. J Interview 2, 12/14/06)

He noted that his students would not be “able to apply the [whole complex] systems engineering process because that takes experience” (Dr. J Interview 2, 12/14/06).

Dr. J Compared to Dr. Davis

After describing the relationship between Dr. J’s espoused beliefs and his classroom practices using technology through this vignette, this section compares the results to Martin et al.’s (2000) vignette of Dr. Davis. The category of description for the object of study (according to Martin et al. and as described in Chapter 3) with which Dr. J was identified was Category D: “Student understanding of the subject matter in relation to professional practice. The teacher engages the student with the elements of professional practice” (Martin et al., p. 393). The category of description for approaches to teaching (according to
Martin et al., and as described in Chapter 3) with which Dr. J was identified was Category E. According to Martin et al., in this category:

- The teacher engages the students in the practice of the discipline with the intention of helping students develop their conceptual understanding. With this approach to teaching the teacher’s intention is to enable the student to learn the material through practicing the discipline knowledge, engaging with the material in ways similar to that of the qualified practitioner (p. 395).

The relationship between Dr. J’s and Dr. Davis’s espoused beliefs and classroom practices using technology is classified in Table 5.5.

- When compared to the results from Martin et al. (2000), Dr. J’s Object of Study Category, Category D, was an exact fit with Dr. Davis’s Object of Study Category. Dr. J’s Approaches to Teaching Category, Category E, was not an exact fit with any of Martin et al.’s interviewed teachers, therefore I chose Dr. Davis as the closest fit because Dr. J and Dr. Davis had approaches to teaching that were both student focused. The difference in their approaches to teaching was that Dr. Davis’s were more developed (highest level category, see Chapter 3 for further details) than Dr. J’s approaches to teaching. Martin et al. described Category F, Dr. Davis’s Approaches to Teaching Category as:

- The teacher engages the students in challenging their discipline understanding/professional practice with the intention of helping students to change their conceptual understanding. With this approach to teaching the teacher’s intention is to change the student’s conception of the practice of the profession through challenging existing conceptions. (p. 395)
Table 5.5. The Fit Between Dr. J’s and Dr. Davis’s Espoused Beliefs and Teaching with Technology (according to Martin et al., 2000)

<table>
<thead>
<tr>
<th>Approaches to teaching</th>
<th>Knowledge given</th>
<th>Knowledge constructed/problematic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Teacher focus</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>Student focus</td>
<td>Dr. J</td>
<td>Dr. Davis</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>

Dr. Davis taught a different discipline within a different context (Martin et al., p. 403) than Dr. J.

Dr. Davis’s intentions were to “give the students a range of learning experiences through which they could develop a framework to help them in future practice” (Martin et al., 2000, p. 405). Dr. Davis’s intentions were different from Dr. J’s intentions, in that Dr. J’s intentions were to help his students improve their understanding of the course materials in order to be able to apply them into real world environments with experienced professionals. Dr. Davis, according to Martin et al., wanted his students to adopt a ready-made framework in which to include their personal readings, reflections, and professional practice. This was different from Dr. J, in that Dr. J presented information to the students and assigned homework to reinforce the course materials, but yet similar, in
that Dr. J had course topics for students to choose from at the beginning of class in order for them to develop a research paper from their own understanding of the course materials.

Dr. J’s and Dr. Davis’s observed practices were similar in that they both aimed to “engage the student[s] with elements of professional practice” (Martin et al., 2000, p. 393). In Dr. Davis’s class the students first dissected the brain in order to understand how the brain is connected to the body, then found variations and anomalies “between what they see and what is represented in their textbook” (Martin et al., p. 405). Dr. Davis’s intentions were to have the students learn from other students, their textbook, “to see each detail as part of an integrated whole,” and to learn from presenting to their peers and teachers (p. 405). In Dr. J’s lectures (as noted in the Classroom Observations above) the students were first presented the information and course materials, then asked questions about the materials presented. Then he encouraged student questions and demonstrated examples of the course materials in order for the students to understand the course materials. His intentions were to have the students learn from other students, their course materials, and in the process, learn how to apply the fundamentals of systems engineering in relation to the complex processes of systems engineering.

Both Dr. J and Dr. Davis brought their students into a relationship with the subject matter by enabling their students to explore and make sense of the course materials. Dr. J demonstrated examples; asked many questions; answered many questions; assigned homework, one of which required students to pair up and evaluate the other’s work; and assigned a semester-long research paper for the course. His intentions were “to enable the students to learn the material through practicing the discipline knowledge, engaging with
the material in ways similar to that of the qualified practitioner” (p. 395). Dr. Davis’s course was different than Dr. J’s, in that it emphasized the “student’s own explorations and sense making” (p. 406) through student presentations. The students were to present the findings to their peers and were subject to evaluation from their peers and the teachers. Dr. Davis’s intentions were to “develop a conceptual change within the student” (p. 406) in order “to move them to a particular view of the doctor, a doctor who investigates and inquires” (p. 406).

Both Dr. J and Dr. Davis reflected on their practice. Dr. J believed that presenting the fundamentals of systems engineering and demonstrating real world examples in his course enabled his students to understand the course materials in a meaningful way relating to professional practice (Martin et al., 2000, p. 393). Similarly, Dr. Davis believed that doing a dissection and having students present to and be evaluated by their peers and teachers enabled the students to “engage with the elements of professional practice” (Martin et al., p. 393).

Summary

The second case study examined the relationship between Dr. J’s espoused beliefs and classroom practices using technology. In order to understand the relationship, I triangulated multiple data sources and compared the findings to Martin et al. (2000). The findings indicated that Dr. J’s espoused beliefs and classroom practices, including the use of technology were similar and consistent.
CHAPTER VI

DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

Introduction

Engineering programs strive to continually improve offerings in higher education, including the application of technology to increase access to adult learners who cannot attend universities because they are working in the field. This research studied two engineering faculty members’ beliefs and classroom practices, including the use of technology, in the teaching of two distinct engineering courses to a variety of graduate students, some of whom were on campus and others who were studying at a distance through a center for EDE in a midwestern university (e.g., off-campus students).

This concluding chapter starts with a summary of the findings concerning the two faculty members’ espoused beliefs and observed classroom practices before connecting these to faculty members’ preparation for instruction. The second part of the chapter summarizes findings relating to technology, starting with the faculty members’ beliefs and practices using technology, followed by the findings pertinent to the members of staff in the EDE unit that supported faculty use of technology in their instruction. The chapter ends with a summary of recommendations that emerged from this original research study for improving practice and future research.

The two rich case studies produced were not seen as contrasting cases in terms of good or bad practice, but were identified as two uniquely different case studies in order to explore the relationship between engineering faculty members’ espoused beliefs and classroom practices using technology, including useful contrasts in this relationship. Each
professor had a different background, different students, and was employed in different departments at the university. However, the common context of EDE provided an interesting commonality to this research on faculty innovation with instructional technology. The rich case studies researched in this university’s College of Engineering EDE unit illustrate the influence of faculty espoused beliefs and classroom practices, faculty teacher preparation on their beliefs and practices, faculty pedagogical beliefs on their course delivery with technology, and pedagogical roles of the faculty members and the EDE staff members. The results are now discussed.

Faculty Espoused Beliefs and Classroom Practices

The case studies were analyzed using two theoretical frameworks for beliefs and one theoretical framework for classroom practices: Shraw et al.’s (2002) five hypothesized beliefs, measured by the EBI, and Martin et al.’s (2000) Course Objectives Categories and Approaches to Teaching categories. This research found a good fit with two of Martin et al.’s five Object of Study categories (C and D) and two of Martin et al.’s six Approaches to Teaching categories” (D and E). The two cases studied were not expected to cover all categories, and it was interesting to find two distinct categories covered by two different case studies. The EBI was useful in this research investigation. From the EBI and semi-structured interview findings I inferred that both faculty members’ epistemic beliefs and espoused beliefs were consistent (this will be discussed later in the chapter). This is the first time that the EBI has been applied at the same time as Martin et al.’s categories. A summary of evidence on both frameworks is provided in Table 6.1.
Table 6.1. A Summary of the Two Faculty Members’ Epistemic Beliefs, Espoused Beliefs, and Approaches to Teaching

<table>
<thead>
<tr>
<th>EBI categories (Shraw et al., 2002)</th>
<th>Dr. K</th>
<th>Dr. J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omniscient Authority</td>
<td>2.80</td>
<td>3.60</td>
</tr>
<tr>
<td>Simple Knowledge</td>
<td>2.42</td>
<td>2.57</td>
</tr>
<tr>
<td>Quick Learning</td>
<td>2.40</td>
<td>1.40</td>
</tr>
<tr>
<td>Certain Knowledge</td>
<td>2.38</td>
<td>3.00</td>
</tr>
<tr>
<td>Fixed Ability</td>
<td>2.14</td>
<td>2.43</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Object of Study (Martin et al., 2000)</th>
<th>Category C</th>
<th>Category D</th>
</tr>
</thead>
<tbody>
<tr>
<td>“To make the students understand what are the fundamental issues in machine processes and how they can make the processes more effective and more efficient and to put these things together to design processes” (Interview 2, 4/25/06)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Approaches to Teaching (Martin et al., 2000)</th>
<th>Category D</th>
<th>Category E</th>
</tr>
</thead>
<tbody>
<tr>
<td>“First I cover some basics of the manufacturing process so they understand the fundamental aspects and then I cover from some research papers and that is like the intermediate step and then you will see that in the next couple of lectures that I will start talking about some design aspects so that is kind of the flow of the course” (Interview 1, 3/30/06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“The main purpose when the students get done is to at least have a basic understanding of what systems engineering is . . . ” (Interview 2, 12/14/06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“I particularly talk about things in lecture and then if I am going to use some software we introduce how you would work through things . . . like the general Monte Carlo and here is how you do things on a Spreadsheet . . . we talked about simulation and then I did an actual Monte Carlo simulation…but I also talked about Discrete Event Simulation [and the students] don’t have [access to] the software so I didn’t do it . . . of course we talked about it first, we did it by hand and they had to do an assignment that involved using a Spreadsheet . . .” (Interview 2, 12/14/06)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The EBI measured the five hypothesized beliefs for each faculty member (please see Chapter 4 and 5 for further details). The data supported the findings that Dr. K had strong epistemic beliefs that fit best in the cognitive realm of knowledge accumulation and synthesis. In contrast, Dr. J agreed with Shraw et al.’s (2002) epistemic belief that authorities have access to otherwise inaccessible knowledge. Dr. J believed he had access to information and otherwise inaccessible simulations to which students did not have access. However, he made this information available to his students at their convenience. The data supported the findings that Dr. J had strong epistemic beliefs that best fit in the cognitive realm of understanding.

These EBI results were also useful in comparing each faculty member’s epistemic beliefs with his espoused beliefs in order to identify the fit between epistemic beliefs and espoused beliefs. For instance, Dr. K’s espoused beliefs fit best within Martin et al.’s (2000) Category C, “student understanding of the subject matter in relation to the discipline as a whole. The teacher introduces a body of knowledge and the ways in which this knowledge has been developed is explored and applied” (p. 393). The quotes selected from Dr. K’s interviews are used to illustrate these findings in Table 6.1. When compared to Dr. K’s epistemic beliefs from the EBI, I found that Dr. K’s epistemic beliefs were a fit with his espoused beliefs (please see Dr. K’s Espoused Beliefs in Chapter 4 for more details).

Dr. J’s espoused beliefs fit best within Martin et al.’s (2000) Category D, “student understanding of the subject matter in relation to professional practice. The teacher engages the student with elements of professional practice” (p. 393). The quotes from Dr. J’s interviews were used to support these findings. When compared to Dr. J’s epistemic beliefs
from the EBI, I found that Dr. J’s epistemic beliefs were also a good fit with his espoused beliefs (please see Dr. J’s Espoused Beliefs: EBI Results in Chapter 5).

When comparing Dr. K’s espoused beliefs and his approaches to teaching, I identified similarities between the main objectives and the role of technology in his course and disconnects between his teaching approach and his course management (please see Table 4.3). Dr. K espoused a student-centered teaching approach, however, I observed a teacher-centered approach. Dr. K espoused beliefs that he was a facilitator of his course and course discussion, although I observed that he was a content expert of his course and that he did not facilitate course discussion. However, he was a facilitator, but only in that he addressed the course content with multiple perspectives so students could start to develop their own understanding of the course material. He engaged students “with discipline knowledge with the intention of helping students develop their own conceptual understanding” (Category D: Approaches to Teaching, Martin et al., 2000, p. 395).

In contrast, Dr. J’s espoused beliefs were a good fit with his approaches to teaching. There were no differences identified between his teaching approaches, the main objective of his course, his course management, or the role of technology in his course (please see Table 5.5). D. J used different teaching methods, techniques, and tools in his classroom in order to transmit the course information to his students. During the classroom observations, Dr. J used his expertise in the content in order to transmit the course information to his students, and he was a facilitator, in that he addressed course content with multiple perspectives so that his students could develop their own understanding of the course material for real-world applications. Dr. J’s intentions were “to enable the student[s] to
learn the material through practicing the discipline knowledge, engaging with the material in ways similar to that of the qualified practitioner” (Category E, Martin et al., 2000, p. 395).

Faculty Teacher Preparation on Their Beliefs and Practices

There have been “many academics [who] have had little or no formal teacher education to prepare them for the teaching role” (Kane et al., 2002, p. 181; please see Faculty Preparation in Chapter 2 for further details). Faculty members with greater preparation to teach appear to have more sophisticated beliefs that are more coherent with practice and use a greater variety of technology. “One way in which the pedagogical knowledge of [novice] and [exemplary] teachers differs is in the number of effective strategies with which . . . they are familiar” (Hative et al., 2001, p. 722). However, “for teacher education or professional development experiences to be successful in supporting meaningful change, they must take into account and address teachers’ knowledge and beliefs” (Putnam & Borko, 1997, p. 1281). A variety of other researchers support this view: …fundamental changes in the quality of university teaching and learning are not likely to occur without changes to the instructors’ conceptions of teaching (Kember & Kwan, 2000, p. 489; McAlpine & Weston, 2000, p. 377).

This research found that the faculty member with more formal preparation had better alignment between his espoused beliefs and his classroom practices. For instance, Dr. K had been a teaching assistant during his graduate studies but did not have any formal preparation. In contrast, Dr. J had a variety of educational experiences with instructional techniques and methods, including study of formal courses on instructional methods for
integrating math into the K-12 classroom as a pre-service teacher in mathematics education. He also discussed his participation in educational sessions in order to learn new methods for improving student interaction and student learning. The last educational experience Dr. J had before becoming a faculty member was teaching in his own classroom as an instructor while he completed his master’s degree. Dr. J’s professional preparation appeared to enable him to learn new technologies and to integrate them into his course with a variety of techniques and methods in order to improve students’ understanding of the course materials. When technologies were found to be impractical in his course, Dr. J would find other technologies that were useful and remove the ones that were not useful.

Both engineering faculty members based their teaching approaches on their previous experiences and beliefs about their course, their discipline, and their content area. This confirms Quinlan (1999) who indicated that faculty members base their objectives for their courses on their own beliefs, their teaching, and their discipline. Both faculty said that they learned about innovations from their peers, by reading about them, and by researching them on the Internet and in publications in order to understand if the innovations were useful and were better than the innovations that were already in place in their learning and teaching. These findings were similar to the findings from Verloop et al. (2001), who found that teachers share their knowledge with other teachers “or large groups of teachers . . .” (p. 443). Putnam and Borko (1997) affirmed that:

…by interacting within various discourse communities, in face-to-face interaction, and through other means of communication such as books and electronic email, individuals come to understand and think in ways that are common to those
communities while simultaneously helping the thinking of the community develop and change” (p. 1281).

Faculty Pedagogical Beliefs on Their Course Delivery with Technology

Both faculty members used a variety of delivery methods to communicate their course materials to their students. Each faculty member used PowerPoint presentations as his main method of course delivery, including presenting course materials to his students. The faculty members also gave different reasons for implementing this approach into their classroom: Dr. K implemented PowerPoint because it helped him demonstrate equations, and Dr. J stated that he used PowerPoint because it helped him organize information and he used the whiteboard to demonstrate and derive equations for his students.

The professors’ pedagogic beliefs were also different. Dr. K had beliefs that all people, in general, have a concept map of their life experiences categorized and organized in their minds (please see Chapter 4 for further details). In contrast, Dr. J wanted his students to be able to go out into the professional field and use the knowledge, processes, and tools with others with experience, as well as to learn how to best apply the processes and tools in order to design (please see Chapter 5 for further details).

I used Larreamendy-Joerns and Leinhardt’s (2006) predominant pedagogical views to classify each faculty members’ pedagogical views in online instruction (please see Faculty Adoption of Technology in Chapter 2 for further details) and compared these findings to the faculty members’ approaches to teaching (Martin et al., 2000) identified in Chapters 4 and 5. I identified that there was a fit between each of the faculty members’ online pedagogical views and their observed classroom instruction. The fit between the
pedagogical views (Larreamendy-Joerns & Leinhardt) and Martin et al.’s “Approaches to Teaching” categories, supported with quotations from my observations of the faculty members’ classroom practices, are seen in Table 6.2.

Dr. K’s presentational view fit with his approaches to teaching, which was evident from his observed classroom instruction. His classroom presentations were rich in representational formats (e.g., notational systems, test, and graphics) and were embodied in distinct ways (e.g., PowerPoint presentations, blue note paper, archived lectures, WebCT, etc.; Larreamendy-Joerns & Leinhardt, 2006). Dr. K provided PowerPoint lectures to his students during the lectures and posted his PowerPoints to his WebCT environment for students to view at their convenience. “In the classroom, explanations [were] punctuated by gestural language and [with] a voice and a temperament” (Larreamendy-Joerns & Leinhardt, p. 585). I found that Dr. K’s voice fluctuated when he discussed materials of great importance or when he wanted to emphasize materials to his students (as seen in the archived lectures). Dr. K also conveyed perspectives of his discipline to his students, including the relative significance of the course materials (Larreamendy-Joerns & Leinhardt).

Dr. J’s epistemic-engagement view fit with his approaches to teaching, which was evident in the way that he structured his systems engineering course for his students (as I observed in his classroom practices). His students would come to “understand not only [the] substantive structure (i.e., facts, concepts, theories), but also its syntax—that is, the questions that guide inquiry, the tools that allow inferences and interconnections, and the
Table 6.2. Faculty Members’ Pedagogical Views and Approaches to Teaching, with Evidence from Classroom Observations

<table>
<thead>
<tr>
<th>Faculty member</th>
<th>Pedagogical views(^a)</th>
<th>Approaches to teaching(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. K</td>
<td>The Presentational View</td>
<td>Category D</td>
</tr>
<tr>
<td></td>
<td>“The way I do it is first I cover some basics of the manufacturing process [in PowerPoint] so they understand the fundamental aspects and then cover from some research papers and that is like the intermediate step and then . . . I will start talking about some design aspects [using PowerPoint] . . .” (Interview 1, 3/30/06)</td>
<td>“At first you have to accumulate knowledge and then you have to analyze it and then you try to synthesize with it . . . and in a graduate class you can take and synthesize because synthesis is where today’s economy and globalization is where the value is—an employer values skills if you can synthesize, so those are the skills that we shoot for . . .” (Interview 1, 3/30/06)</td>
</tr>
<tr>
<td></td>
<td>Dr. K employed a lecture-based technique throughout the lecture by sitting in front of class presenting information to his students. . . . For this lecture, Dr. K embedded three simulations into his PowerPoint slides in order to help his students “see” the grinding process [the recorded lectures and course materials were posted on Dr. J’s WebCT site for students to access at their convenience] (Researcher notes, 4/6/06)</td>
<td>When students were asked a question that they could not answer, Dr. K repeated the material in a different context and with a different metaphor to try to make students think about the material in a way that made sense to them. Dr. K did not specifically ask the students if they understood the information or if one of them could explain the information in their own words (Researcher notes, 4/13/06)</td>
</tr>
<tr>
<td></td>
<td>There was a large amount of content presented to the students during this lecture [via PowerPoint] (Researcher notes, 4/11/06)</td>
<td></td>
</tr>
<tr>
<td>Dr. J</td>
<td>The Epistemic-Engagement View</td>
<td>Category E</td>
</tr>
<tr>
<td></td>
<td>“The first goal is for [the students] to learn the basics of systems engineering, what are the basics of systems engineering . . . what is it?, why do we have it?, how long has it been around?, what do you use it for?, and then what is the general process for system engineering? . . . after we talk about the process and how you would implement the process and the things you need to consider, what a system engineer does, and so far . . . then we go into the tools that a system engineer would use” (Interview 1, 11/13/06)</td>
<td>“At least on a small scale . . . go out and then use the knowledge and the process they have learned and the tools that we have talked about in class . . . and with others with experience, learn how to best apply the process and the tools . . . in order to design something . . . so ultimately they are going to be able to be designing” (Interview 2, 12/14/06)</td>
</tr>
<tr>
<td></td>
<td>Dr. J wanted the students to think about the course materials and try to understand them . . . he asked the students many different questions throughout the lecture [this was consistent throughout all lectures] . . . Dr. J gave other examples to help clarify the material; he gave different examples until the students nodded and acted as though they understood the material (Researcher Notes, 11/07/06)</td>
<td>Dr. J brought a piece of software, that he developed, to demonstrate to the students in order for his students to “see” the simulation and ask questions. . . . Dr. J used the instructor PC to demonstrate the simulation . . . he used the whiteboard during the lecture to write out equations and present different methods . . . he used pre-made notes to help guide him throughout the lecture . . . he also tried to capture his students interest in the simulations by stating during the lecture that, “the annealing process was fun to play with and powerful” (Researcher notes, 11/16/06)</td>
</tr>
<tr>
<td></td>
<td>Dr. J scaffolded his students’ learning in many ways throughout the course. He gave his students step-by-step information about the course materials. He gave his students advice to print out the annotated notes and compare them to the archived lectures in order to improve their understanding of the material covered during lecture (Researcher notes, 11/7/06)</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Larreamendy-Joerns & Leinhardt (2006). \(^b\) Martin et al. (2000)
actions and principles (rules) that validate knowledge” (Larreamendy-Joerns & Leinhardt, 2006, p. 590). He asked his students many questions during each lecture, gave a variety of examples, and scaffolded his students understanding of the course materials. Dr. J’s students were given a variety of “opportunities for participatory practice and, as competencies [developed], they [sought] and [obtained] supporting skills and concepts” (Larreamendy-Joerns & Leinhardt, p. 590). Dr. J provided PowerPoint lectures to his students before and after class, so his students could follow along with the lecture as it was being recorded and then they could compare the annotated notes with the archived lectures after the lecture was finished. His students completed homework assignments after each topic to reinforce the course materials, including the group project, in which one student paired with another student to critique each other’s work.

There was an interesting fit between the pedagogical views of online instruction and the faculty member’s approaches to teaching, such that the presentational view fit with category D and the epistemic-engagement view fit with category E, using evidence from my classroom observations. As a staff member in EDE, I believe that EDE supports all pedagogical views identified by Larreamendy-Joerns and Leinhardt (2006) and that EDE staff worked hard to meet the needs of the faculty members when they taught in the EDE classrooms. Engineering faculty members’ used EDE’s innovative support for a variety of reasons. EDE could make greater use of these characteristics to make improvements and refine its services.
Pedagogical Roles of the Faculty Members and the Engineering Distance Education Staff Members

Recent research in educational change with virtual schooling (Harms, Niederhauser, Davis, Roblyer, & Gilbert, 2006) indicated that roles change and become decoupled. In this study the role of the faculty member, the role of the EDE staff, and the roles of the students in EDE may be decoupling just as the roles have been decoupled with technology in the sectors for K-12 into three roles (Harms et al., ¶28-36). The decoupling was found to apply to off-campus students only. For example, assignments: The instructors wrote the assignments and distributed them via email or WebCT to the on- and off-campus students; the EDE administrative staff collected the off-campus students’ completed assignments; the EDE technical support staff designed the template for WebCT and the assignments tools; the EDE student producer staff scanned graded assignments, saved scanned assignments on the EDE WebCT server, and emailed assignments back to off-campus students through WebCT; and the off-campus students collected the assignments via email and/or WebCT, completed the assignments, and sent them to either the EDE administrative staff or directly to the instructor of their course for grading. The on-campus section of the course had traditional roles, as seen in face-to-face courses where the instructor writes, distributes, collects, grades, and returns graded assignments to the on-campus students. Table 6.3 presents the range of pedagogical roles of the faculty member, EDE staff members, and the students.

Further reflection on the two cases presented in Chapters 4 and 5 show that the faculty members’ roles were partially decoupled, especially for off-campus students. EDE
is set up to mimic current on-campus practice in a way that minimizes disruption of pedagogy. Nevertheless, from the perspective of the distance students, the courses were delivered by both the faculty members and the EDE staff members who designed and managed the technology platforms (e.g., EDE classroom and the WebCT environment). The staff also worked to support faculty members’ pedagogical adaptations that resulted in continuing development of their courses taught in the EDE unit. It is recommended that EDE consider increasing the decoupling of these roles and adoption of pedagogies developed by distance education universities, such as The Open University in the United Kingdom (http://www.open.ac.uk/) and Laurillard (2002). Although this research studied only faculty beliefs, the decoupling suggests that pedagogical beliefs of both faculty and staff members may impact practice.

Recommendations

This research investigation successfully addressed the research question first introduced in Chapter 1: How do engineering faculty member’s espoused beliefs relate to his/her observed classroom practices using technology? According to the findings in the two rich case studies, I found that the engineering faculty members’ espoused beliefs were a good fit with their observed classroom practices using technology, with the exception of Dr. K’s teaching approaches and course management techniques as discussed above and presented in Table 4.3. Formal professional development appeared to increase the coherence between faculty members’ espoused beliefs and classroom practices, including the use of technology. Although it is impossible to generalize from two case studies, it is recommended that future researchers continue to investigate this phenomenon.
Table 6.3. Pedagogical Roles of the Faculty, the EDE Staff Members, and the Students (shaded portions apply to off-campus students only)

<table>
<thead>
<tr>
<th>Faculty member</th>
<th>EDE Staff Members</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Administrative</td>
<td>Technical</td>
</tr>
<tr>
<td></td>
<td>staff</td>
<td>support</td>
</tr>
<tr>
<td>Made PowerPoint presentations</td>
<td>Registered off-campus students</td>
<td>Enrolled off and on-campus students into WebCT courses</td>
</tr>
<tr>
<td>Facilitated instruction using WebCT, telephone, and electronic mail</td>
<td>Facilitated homework, exams, assignments, and program documentation for faculty and students</td>
<td>Designed, facilitated, and maintained the WebCT environment</td>
</tr>
<tr>
<td>Communicated with students via electronic mail, telephone, and office visits</td>
<td>Mediated communication between faculty members and students (electronic mail, phone, face-to-face meetings, WebCT)</td>
<td>Communicated technology help with students and faculty members via WebCT</td>
</tr>
<tr>
<td>Posted materials on WebCT</td>
<td>Facilitated tuition and delivery fees with students</td>
<td>Posted materials on behalf of the faculty (more for Dr. K)</td>
</tr>
<tr>
<td>Asked students questions during class</td>
<td>Emailed end of the semester course evaluations to students</td>
<td>Ensured access to:</td>
</tr>
<tr>
<td>Answered questions by email, phone, and in the office</td>
<td>Answered questions and addressed concerns via electronic mail, telephone</td>
<td></td>
</tr>
</tbody>
</table>
Formal professional development may be applied as a criterion for consideration when selecting and recruiting engineering faculty as well as increasing planning and support for faculty development. Given the decoupling of roles, it is also recommended that EDE staff members also improve their understanding of pedagogical beliefs and teaching practices by engaging in professional development activities. It is recommended that future research studies examine the beliefs of the students, the teachers, and the staff members who support distance education to identify the impact of their beliefs on practice.

The EBI was useful and it is recommended that comparable administration procedures and comparable groups with the same version of the instrument be used for further research (Schommer-Aikins, 2002). Martin et al.’s (2000) categories also were useful and are recommended for further research. It is recommended that similar cases be conducted and compared to Dr. K’s and Dr. J’s cases as well as researching new cases with the intention of identifying all of Martin et al.’s Approaches to Teaching and Object of Study categories. In doing so, researchers may confirm these or may find limitations to the current categories, which may lead to the creation of new categories for classifying and organizing engineering faculty members’ beliefs and practices, including the use of technology.

In addition, staff supporting faculty development and potential distance education faculty members could apply Martin et al.’s (2000) categories to improve support and possibly encourage further development toward more student-centered approaches that are currently researched in reviews of higher education. In addition, the EDE unit and related resources were designed to support expanded access to the sort of course delivery common
in campus-based engineering courses, with the exception of labs and practical activities. Given that both faculty members found this restrictive, it is strongly recommended that EDE develop instructional strategies for labs and other practical activities.
APPENDIX A

SUMMARY OF SEMI-STRUCTURED INTERVIEW QUESTIONS (FACULTY): BEFORE AND AFTER

Adapted and modified from Martin, Prosser, Trigwell, Ramsden, & Benjamin (2000):

What is the main objective of your course? Do you have any other objectives for your course? If yes, what are they?

How are students brought into active connections with the main objective for the course? How are students brought into relations with other objectives for your course?

What are your approaches to teaching?
What are your approaches to learning?

What are the desired learning outcomes of your course?
APPENDIX B

SUMMARY OF FOCUS GROUP QUESTIONS: SEMI-STRUCTURED (STUDENTS)

Adapted and modified from Martin, Prosser, Trigwell, Ramsden, & Benjamin (2000):

What is the main objective of your course, in your opinion? From the syllabus? From the instructor?

How are you brought into active connections with the subject matter? Do you do group work? Do you have individual projects? Do you do work together in class? What are your instructor’s approaches to teaching? What are your instructor’s approaches to learning?

What are the desired learning outcomes of the course, from your perspective?
Greetings [Name Here],

My name is Lara Hagenson, a Ph.D Candidate in Curriculum and Instruction, specializing in Curriculum and Instructional Technology. I am currently undertaking a pilot study to explore engineering faculty members’ professed beliefs and their observed classroom practice, plus their students’ perceptions of their observed classroom practice. I understand that you are an off campus student taking [course] through Engineering Distance Education at [this Midwestern university] and that you may be willing to participate in a phone interview about your course. The interview will last approximately 10-20 minutes.

Your participation in this study is completely voluntary and you may refuse to participate or withdraw from the study at any time. If you decide not to participate in the study or withdraw from the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled. Data from participants who withdraw will be deleted from the data selected for analysis. You will not incur any costs from participating in this study. You will not be compensated for participating in this study.

Your verbal agreement to participate indicates that you voluntarily agree to participate in this study, that the study has been explained to you, and that your questions have been satisfactorily answered.

Do you have questions about the study procedures or content?

Do you agree to participate in this research study? Yes  No

Thank you very much for your time. Please ask questions at any time throughout the interview.

Interview Questions:

What is the main objective of your course, in your opinion? From the syllabus? From the instructor?

How are you brought into active connections with the subject matter? Do you do group work? Do you have individual projects? Do you do work together in class?
  What are your instructor’s approaches to teaching?
  What are your instructor’s approaches to learning?

What are the desired learning outcomes of the course, from your perspective?
APPENDIX D

STRATEGY FOR OBSERVATION (FACULTY AND STUDENTS)

Adapted and modified from Martin, Prosser, Trigwell, Ramsden, & Benjamin (2000):

Observation #:

Lecturer’s intentions:
Objectives:
  Teacher/student interaction:
  Variety of Techniques (Describe):
  Teacher Talk vs. Student Talk:
APPENDIX E

DOCUMENT ANALYSIS OF FACULTY COURSE

Document Analysis (Course Content)

Syllabus

Course Information

WebCT Environment
Streaming Lectures
APPENDIX F

EPISTEMOLOGICAL BELIEFS INVENTORY
(Schraw, Bendixen, & Dunkle, 2002)

Please indicate how strongly you agree or disagree with each of the statements listed below. Please circle the number that best corresponds to the strength of your belief.

It bothers me when instructors don’t tell students the answers to complicated problems.
Strongly 1  2  3  4  5  Strongly Agree
Disagree

Truth means different things to different people.
Strongly 1  2  3  4  5  Strongly Agree
Disagree

Students who learn things quickly are the most successful.
Strongly 1  2  3  4  5  Strongly Agree
Disagree

People should always obey the law.
Strongly 1  2  3  4  5  Strongly Agree
Disagree

Some people will never be smart no matter how hard they work.
Strongly 1  2  3  4  5  Strongly Agree
Disagree

Absolute moral truth does not exist.
Strongly 1  2  3  4  5  Strongly Agree
Disagree

Parents should teach their children all there is to know about life.
Strongly 1  2  3  4  5  Strongly Agree
Disagree
Really smart students don’t have to work as hard to do well in school.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

If a person tries too hard to understand a problem, they will most likely end up being confused.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

Too many theories just complicate things.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

The best ideas are often the most simple.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

People can’t do too much about how smart they are.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

Instructors should focus on facts instead of theories.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

I like teachers who present several competing theories and let their students decide which is best.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

How well you do in school depends on how smart you are.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>
If you don’t learn something quickly, you won’t ever learn it.

Strongly Disagree

Some people just have a knack for learning and others don’t.

Strongly Disagree

Things are simpler than most professors would have you believe.

Strongly Disagree

If two people are arguing about something, at least one of them must be wrong.

Strongly Disagree

Children should be allowed to question their parents’ authority.

Strongly Disagree

If you haven’t understood a chapter the first time through, going back over it won’t help.

Strongly Disagree

Science is easy to understand because it contains so many facts.

Strongly Disagree

The moral rules I live by apply to everyone.

Strongly Disagree
The more you know about a topic, the more there is to know.

Strongly Disagree Agree
1 2 3 4 5 Strongly Agree

What is true today will be true tomorrow.

Strongly Disagree Agree
1 2 3 4 5 Strongly Agree

Smart people are born that way.

Strongly Disagree Agree
1 2 3 4 5 Strongly Agree

When someone in authority tells me what to do, I usually do it.

Strongly Disagree Agree
1 2 3 4 5 Strongly Agree

People who question authority are trouble makers.

Strongly Disagree Agree
1 2 3 4 5 Strongly Agree

Working on a problem with no quick solution is a waste of time.

Strongly Disagree Agree
1 2 3 4 5 Strongly Agree

You can study something for years and still not really understand it.

Strongly Disagree Agree
1 2 3 4 5 Strongly Agree

Sometimes there are no right answers to life’s big problems.

Strongly Disagree Agree
1 2 3 4 5 Strongly Agree
Some people are born with special gifts and talents.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

APPENDIX G

SEMI-STRUCTURED INTERVIEW QUESTIONS (FACULTY):
BEFORE AND AFTER

Adapted and modified from Martin, Prosser, Trigwell, Ramsden, & Benjamin (2000):

What is the main objective of your course? Do you have any other objectives for your course? If yes, what are they?

How are technologies used to meet the main objectives of your course?

How are students brought into active connections with the main objective for the course?

How are students brought into relations with other objectives for your course?

What technologies do you use in connection with your course (e.g. Webct (streaming lectures, discussion board, university emails), telephone, etc.)? Prompt the instructor to discuss various technologies used in the course. For each technology addressed, ask what the intended purpose is from their perspective.

What technologies will be used again?

What are your approaches to teaching? How do you use technologies to enhance your approaches to teaching?

What are your approaches to learning? How do you use technologies to enhance your approaches to learning?

What are the desired learning outcomes of your course? How do you use technologies to achieve the desired learning outcomes of your course?

Describe briefly 2 contrasting projects or papers that were submitted.

Are the projects (papers) different for on and off campus students? If so, please explain.
APPENDIX H

FOCUS GROUP QUESTIONS: SEMI-STRUCTURED (STUDENTS)

Adapted and modified from Martin, Prosser, Trigwell, Ramsden, & Benjamin (2000):

What is the main objective of your course, in your opinion? From the syllabus? From the instructor?

How are technologies used to meet the main objectives of your course?

How are you brought into active connections with the subject matter? Do you do group work? Do you have individual projects? Do you do work together in class?

What technologies does your instructor use in connection with your course (e.g. WebCT (streaming lectures, discussion board, university emails), telephone, etc.)? For each technology addressed, ask what the intended purpose is from their perspective.

What are your instructor’s approaches to teaching?

From your perspective, does your instructor use technologies to enhance his approaches to teaching?

What are your instructor’s approaches to learning?

From your perspective, does your instructor use technologies to enhance his approaches to learning?

What are the desired learning outcomes of the course, from your perspective? How does the instructor use technologies to achieve the desired learning outcomes?
APPENDIX I

PHONE INTERVIEW WITH OFF CAMPUS STUDENT

Greetings [Name Here],

My name is Lara Hagenson, a Ph.D Candidate in Curriculum and Instruction, specializing in Curriculum and Instructional Technology. I am currently exploring research focusing on engineering faculty members’ professed beliefs and their observed classroom practice, plus their students’ perceptions of their observed classroom practice. I understand that you are an off campus student taking [course] through Engineering Distance Education at [this Midwestern university] and that you may be willing to participate in a phone interview about your course. The interview will last approximately 10-20 minutes.

Your participation in this study is completely voluntary and you may refuse to participate or withdraw from the study at any time. If you decide not to participate in the study or withdraw from the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled. Data from participants who withdraw will be deleted from the data selected for analysis. You will not incur any costs from participating in this study. You will not be compensated for participating in this study.

Your verbal agreement to participate indicates that you voluntarily agree to participate in this study, that the study has been explained to you, and that your questions have been satisfactorily answered.

Do you have questions about the study procedures or content?

Do you agree to participate in this research study?  Yes  No

Thank you very much for your time. Please ask questions at any time throughout the interview.

Interview Questions:

What is the main objective of your course, in your opinion?  From the syllabus?  From the instructor?

How are technologies used to meet the main objectives of your course?

How are you brought into active connections with the subject matter?  Do you do group work?  Do you have individual projects?  Do you do work together in class?
What technologies does your instructor use in connection with your course (e.g. WebCT (streaming lectures, discussion board, university emails), telephone, etc.)? For each technology addressed, ask what the intended purpose is from their perspective.

What are your instructor’s approaches to teaching?

From your perspective, does your instructor use technologies to enhance his approaches to teaching?

What are your instructor’s approaches to learning?

From your perspective, does your instructor use technologies to enhance his approaches to learning?

What are the desired learning outcomes of the course, from your perspective? How does the instructor use technologies to achieve the desired learning outcomes?

Thank you very much for your time and participation.
Lara
REFERENCES


Hofer, B. (2002). Personal epistemology as a psychological and educational construct: An introduction. In B. Hofer & P. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 3-14). London; Lawrence Erlbaum Associates.


