INVESTIGATING ENGINEERING EDUCATORS’ VIEWS ON THE USE OF
EDUCATIONAL TECHNOLOGY: A Q METHODOLOGY STUDY

A Dissertation

Presented to

The Graduate Faculty of The University of Akron

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

John B. Nicholas

August, 2011
INVESTIGATING ENGINEERING EDUCATORS’ VIEWS ON THE USE OF EDUCATIONAL TECHNOLOGY: A Q METHODOLOGY STUDY

John B. Nicholas

Dissertation

Approved:

Advisor
Susan E. Ramlo, PhD

Department Chair
Bridgie A. Ford, PhD

Co-Advisor/Committee Member
Lynne M. Pachnowski, PhD

Dean of the College
Mark D. Shermis, PhD

Committee Member
D. Dane Quinn, PhD

Dean of the Graduate School
George R. Newkome, PhD

Committee Member
I-Chun Tsai, PhD

Date

Committee Member
Cheryl L. Ward, PhD

ii
ABSTRACT

The purpose of this study is to investigate the views of engineering/engineering technology (E-ET) educators on the use of educational technology in E-ET courses. In this study, views of the use of educational technology were investigated using Q Methodology. William Stephenson developed Q Methodology as a means of measuring subjectivity (Brown 1980, 1993; McKeown & Thomas, 1988). Students’ views on the use of educational technology in science and engineering technology courses have been investigated using Q Methodology (Kraft 2008; Nicholas, 2009, 2010a, 2010b) but very little research has been done on the views of E-ET educators’ views on the subject. The participants of this study were from a mid-sized Midwestern university that houses both engineering and/or engineering technology programs. This study aimed to elicit the views of E-ET educators on the use of educational technology in E-ET courses. A pilot study was conducted during the spring 2010 semester on the use of classroom technology in E-ET courses by the researcher. This study replicated and improved upon the pilot study based on the results of and the post-sort interviews conducted at the conclusion of the pilot study to determine if these three factors or views will replicate and/or new factors or views emerge. The study resulted in three factors or views on the use of classroom technology in E-ET courses that were based in the pedagogy of the participants. These findings should assist those interested in discovering and implementing the best use of educational technology in E-ET education.
ACKNOWLEDGEMENTS

I would like to express my sincere heartfelt appreciation of Dr. Susan E. Ramlo. The process to begin this journey began, in part, with her encouragement. She has been a teacher, friend, counselor, and mentor. I will always remember all she has done to help and support me; her knowledge and experiences were invaluable. I would also like to express my gratitude for Dr. Lynne M. Pachnowski, whose guidance and flexibility throughout this process helped me to avoid many possible pitfalls. I would be remiss to not express my thanks to Dr. Cheryl Ward, Dr. I-Chun Tsai and Dr. D. Dane Quinn, my committee, whose input helped shape the dissertation and challenged me to continually improve.

I would like to thank my mother, Sharon R. Nicholas, for believing in me way back when, my father, John J. Nicholas, for helping to develop the internal drive that has propelled me to achieve this goal, and my daughter Erika L. Nicholas, for being my inspiration for being a better person. Additionally, I would like to thank Dr. Susan Olson and Dr. Qetler Jensrud for suggesting that I consider entering a Doctoral program.
TABLE OF CONTENTS

Page

ABSTRACT ........................................................................................................................................ iii

ACKNOWLEDGEMENTS .............................................................................................................. iv

LIST OF FIGURES .................................................................................................................... xi

CHAPTER

I. THE PROBLEM ..................................................................................................................... 1

   Introduction................................................................................................................................. 1

   Purpose of the Study .............................................................................................................. 2

   Statement of the Problem ...................................................................................................... 5

   The State of Engineering/Engineering Technology Education ........................................ 8

   Educational Technology ....................................................................................................... 12

   Industry Standard Technology .......................................................................................... 13

   Discussion of the Use of Educational Technology in Engineering/Engineering Technology Education ........................................................................................................... 14

   Discussion of Technological Pedagogical Content Knowledge (TPACK) ................... 14

   Significance of the Study ....................................................................................................... 16

   Research Questions ............................................................................................................... 18

   Interview Process ................................................................................................................. 18
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delimitations</td>
<td>19</td>
</tr>
<tr>
<td>Definitions of Operational Terms</td>
<td>20</td>
</tr>
<tr>
<td>Summary</td>
<td>21</td>
</tr>
<tr>
<td><strong>II. REVIEW OF THE LITERATURE</strong></td>
<td>22</td>
</tr>
<tr>
<td>General Background Information</td>
<td>222</td>
</tr>
<tr>
<td>History of Engineering/Engineering Technology Education</td>
<td>24</td>
</tr>
<tr>
<td>Educational Technology</td>
<td>26</td>
</tr>
<tr>
<td>Discussion of the Use of Technology and Educational Technology in</td>
<td>27</td>
</tr>
<tr>
<td>Engineering/Engineering Technology Education</td>
<td>27</td>
</tr>
<tr>
<td>Discussion of Technological Pedagogical Content Knowledge (TPACK)</td>
<td>30</td>
</tr>
<tr>
<td>Q Methodology</td>
<td>35</td>
</tr>
<tr>
<td>Summary</td>
<td>40</td>
</tr>
<tr>
<td><strong>III. PROCEDURES</strong></td>
<td>44</td>
</tr>
<tr>
<td>Derivation of General Research Hypotheses and Specific Research Hypotheses</td>
<td>44</td>
</tr>
<tr>
<td>General &amp; Specific Research Hypotheses</td>
<td>46</td>
</tr>
<tr>
<td>General Research Hypothesis 1</td>
<td>46</td>
</tr>
<tr>
<td>Specific Research Hypothesis 1A</td>
<td>46</td>
</tr>
<tr>
<td>Specific Research Hypothesis 1B</td>
<td>46</td>
</tr>
<tr>
<td>General Research Hypothesis 2</td>
<td>46</td>
</tr>
<tr>
<td>Specific Research Hypothesis 2A</td>
<td>46</td>
</tr>
<tr>
<td>Specific Research Hypothesis 2B</td>
<td>46</td>
</tr>
<tr>
<td>Research Questions</td>
<td>46</td>
</tr>
<tr>
<td>Participants</td>
<td>47</td>
</tr>
</tbody>
</table>
Engineering/Engineering Technology Educators ......................................................... 47
Sampling Procedures ................................................................................................. 49
Research Design ....................................................................................................... 51
A priori research design ......................................................................................... 51
Pilot Study ................................................................................................................ 51
Participants & Demographics of the Pilot Study ...................................................... 52
Development of the concourse for the Pilot Study ................................................ 52
Conclusions of the pilot study .................................................................................. 54
Limitations of the Pilot Study .................................................................................. 55
Methods ..................................................................................................................... 56
Demographic and Educational Technology Usage Survey ..................................... 56
Q-sort ......................................................................................................................... 56
Interviews .................................................................................................................. 58
Data Collection ........................................................................................................ 59
Q-Methodology ......................................................................................................... 59
Developing the Concourse ....................................................................................... 60
Developing the Q Sample ......................................................................................... 61
Conditions of Instruction ......................................................................................... 63
Analysis and Interpretation ..................................................................................... 64
Analysis of the Data ............................................................................................... 66
Factor Interpretation ............................................................................................... 68
Representative Sorts ............................................................................................... 70
Distinguishing Statements ....................................................................................... 71
Consensus statements............................................................................................ 71
Validity in Q Methodology ..................................................................................... 72
Reliability in Q Methodology ................................................................................ 73
Limitations ............................................................................................................. 74
Summary .............................................................................................................. 74

IV. RESULTS OF THE STUDY ................................................................................. 75
Demographic Data for the Study ........................................................................ 75
Data Collection .................................................................................................... 77
Analysis of the Data ........................................................................................... 78
Analysis and Interpretation ................................................................................ 79
Factor Analysis of the Q-sort ............................................................................... 86
Supporting Evidence of Epistemology from Survey Statements ...................... 98
Response to Research Questions ........................................................................ 101
Results of Testing the Research Hypotheses ..................................................... 101
Summary .......................................................................................................... 107

V. SUMMARY, CONCLUSIONS, AND IMPLICATIONS ..................................... 109
Summary of the Study ......................................................................................... 109
Statement of the procedures .............................................................................. 112
The specific research hypotheses .................................................................... 112
Specific Research Hypothesis 1A .................................................................... 112
Specific Research Hypothesis 1B .................................................................... 112
Specific Research Hypothesis 2A .................................................................... 115
Specific Research Hypothesis 2B .................................................................... 115
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Demographic Information</td>
<td>48</td>
</tr>
<tr>
<td>2.</td>
<td>Factor Matrix with an X Indicating a Defining Sort</td>
<td>80</td>
</tr>
<tr>
<td>3.</td>
<td>Factor Values for Each Statement from the study with the distinguishing statements for each factor in bold and consensus statements italicized</td>
<td>82</td>
</tr>
<tr>
<td>4.</td>
<td>Six Most-Like My View Statements for Factor 1 &quot;Student Engagers&quot;</td>
<td>88</td>
</tr>
<tr>
<td>5.</td>
<td>Six Least-Like My View Statements for Factor 1 &quot;Student Engagers&quot;</td>
<td>89</td>
</tr>
<tr>
<td>6.</td>
<td>Distinguishing Statements for Factor 1 &quot;Student Engagers&quot;</td>
<td>89</td>
</tr>
<tr>
<td>7.</td>
<td>Six Most-Like My View Statements for Factor 2 &quot;The Entertainers&quot;</td>
<td>92</td>
</tr>
<tr>
<td>8.</td>
<td>Six Least-Like My View Statements for Factor 2 &quot;The Entertainers&quot;</td>
<td>93</td>
</tr>
<tr>
<td>9.</td>
<td>Distinguishing statements for Factor 2 &quot;The Entertainers&quot;</td>
<td>93</td>
</tr>
<tr>
<td>10.</td>
<td>Six Most-Like My View Statements for Factor 3 &quot;This is how I learned&quot;</td>
<td>96</td>
</tr>
<tr>
<td>11.</td>
<td>Six Least-Like My View Statements for Factor 3 &quot;This is how I learned&quot;</td>
<td>97</td>
</tr>
<tr>
<td>12.</td>
<td>Distinguishing Statements for Factor 3 &quot;This is how I learned&quot;</td>
<td>98</td>
</tr>
<tr>
<td>13.</td>
<td>Educational Technology Used, Answer to Survey and Post-Sort Interview Questions</td>
<td>99</td>
</tr>
<tr>
<td>14.</td>
<td>Educational Technology Used, Answer to Survey and Post-Sort Interview Questions</td>
<td>113</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Two Circles Representing Pedagogical and Content Knowledge in</td>
<td>322</td>
</tr>
<tr>
<td>2</td>
<td>The two circles of Pedagogical Knowledge and Content Knowledge are now joined by pedagogical content knowledge</td>
<td>322</td>
</tr>
<tr>
<td>3</td>
<td>The Three Circles Represent Pedagogy, Content, and Technology Knowledge. Content and Pedagogy Overlap to Form Pedagogical Content Knowledge While Technology Is Seen as Being a Separate and Independent Knowledge Domain</td>
<td>333</td>
</tr>
<tr>
<td>4</td>
<td>Pedagogical Technological Content Knowledge. The Three Circles, Content, Pedagogy, and Technology, Overlap to Lead to Four More Kinds of Interrelated Knowledge</td>
<td>344</td>
</tr>
<tr>
<td>5</td>
<td>Example of a Q-sort grid</td>
<td>377</td>
</tr>
<tr>
<td>6</td>
<td>Example of the Q sort grid used in the study</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>An example of a representative sort from Factor 1 of the pilot study.</td>
<td>700</td>
</tr>
<tr>
<td>8</td>
<td>Q-sort grid used in this study</td>
<td>788</td>
</tr>
</tbody>
</table>
CHAPTER I

THE PROBLEM

The problem and research questions are developed in this chapter. In addition, the researcher discusses the significance of the study. A brief review of the literature provides introductory information related to the five major topics of this study: The history of engineering/engineering technology (E-ET) education, educational technology, technological pedagogical content knowledge (TPACK), and Q Methodology (Q). Operational terms and definitions are also included in this chapter.

Introduction

Educational technology has become commonplace in education, particularly in the K-12 educational (Bowe, 2010). However, its implementation has lagged in higher education, including E-ET education (Michko, 2007, 2008; Bowe, 2010). Engineering education is defined as the activity of teaching engineering at college or university level preparing the graduate for a profession as a practicing engineer. Engineering Technology education defined as the activity of teaching the applied aspects of science and engineering preparing graduates for practice in that portion of the technological spectrum closest to product improvement, industrial processes, and operational functions (ABET, 2010). Where there are some differences in the focus between engineering and engineering technology, the concepts taught in E-ET are the same in the respective disciplines. The difference in the two disciplines lies primarily in the level of math used
(higher mathematics are necessary for engineering) and more application (more hands-on laboratory time in ET). E-ET educators are those who teach E-ET at the undergraduate or graduate level.

Despite calls for implementing educational technology into undergraduate E-ET classrooms by Building Engineering and Science Talent (BEST), The American Society of Engineering Educators (ASEE), and ABET Incorporated (formerly known as the Accreditation Board for Engineering and Technology) and studies that have shown that students are more engaged when educational technology is used in the higher education educational (Bowe, 2010), there has been some reluctance to use educational technology in undergraduate E-ET classrooms (Michko, 2007, 2008; Bowe, 2010).

Educational technology is often misunderstood by educators, which has in turn resulted in some aversion to its implementation in higher education classrooms, including E-ET classrooms (Bowe, 2010). The use of educational technology has the potential to assist the E-ET educator in teaching abstract concepts, teach to a variety of learning styles and help the educator better relate to the twenty-first century learner (Fies and Marshall, 2006).

Purpose of the Study

The purpose of this study is to investigate the subjectivity or views of engineering and engineering technology educators at a public Midwestern university regarding the use of educational technology in E-ET classrooms. Educational technology is defined for this study as both hardware and software used by an instructor for teaching, a student for learning, or both instructor and student. Two examples of educational technology are Classroom Response Systems (clickers) and on-line educational management tools.
Clickers consist of transmitters that students use to send responses, receivers that are connected to a computer that collects these responses. The computer runs software designed to interpret and aggregate these responses in real time (Fies & Marshall, 2006). The instructor has a choice as to how publicly or how anonymously these responses are collected and displayed. The aggregated responses are almost always publicly displayed to inform both instructors and learners of the overall distribution of selections (Fies & Marshall, 2006; Kraft, 2007; Nicholas, 2009, 2010).

Educational technologies, such as clickers, have found their way into the science education world, but have not yet been widely used in E-ET education. Some recent studies on students’ views of the use of educational technology, specifically clickers and on-line educational management tools, have been conducted using Q-methodology (Kraft, 2008; Nicholas, 2009, 2010). Those studies suggest that students respond positively to the use of clickers and on-line educational management tools in science and engineering technology courses.

The relationships between science and E-ET have significant parallels and thus there are significant parallels with the relationships between science education and E-ET education, in fact, engineering is often referred to as a science-based discipline. The parallels science and E-ET are particularly valuable when observing how each group in these two pairings (science-engineering; science education-technology education) sees itself and the other member of the pairing. The most obvious example of this is that just as science tends to see E-ET as applied science, making E-ET a science based discipline. The same concepts taught in science are applied in engineering (Gunstone, 1994; Grimson, 2002; Hills & Tedford, 2003). These parallels are further supported by
Layton’s (1976) description of engineering as the creative science. Layton (1976, p. 690) cites Thomas C. Clarke, then president of the American Society of Engineers, in 1896 as stating “science is the discovery and classification of the laws of nature. Engineering ... is the practical application of such discovered laws.” Because of the many parallels between science education and E-ET education, the use of educational technology in science education can be used as a template for educational technology use in E-ET education.

There are at least three reports that call for a change in the E-ET education teaching curriculum. They are: BEST, 2004; National Academy of Engineering, 2004; National Academy of Engineering, 2005 (Michko, 2007, 2008). All three of these reports intimate that the new technologies can be important tools in increasing efficiency and effectiveness of E-ET education. Despite these reports and studies that show greater student engagement when educational technology is used in higher education courses (Bowe, 2010), E-ET educators have been slow to adopt educational technologies into their courses (Michko, 2007, 2008; Bowe, 2010).

This study will use Q Methodology to determine the views of E-ET educators regarding the use of educational technology in E-ET education courses. The Q-sample or Q statements that will be used for the Q-sorting process are developed from interviews of E-ET educators on the subject during a pilot study (described in Chapter III), general conversations with E-ET educators, post-sort interviews with the participants of the pilot study and a review of the literature. The concourse development process in Q Methodology is discussed in Chapter III. This study aims to understand what barriers, if
any, exist to implementing educational technology into the twenty-first century E-ET educational.

Statement of the Problem

Despite the potential to improve the pedagogy in engineering/engineering technology education by implementing educational technology into the E-ET educational, there is a high level of resistance toward doing so by E-ET educators (Michko, 2007, 2008; Bowe, 2010). This study will investigate the views of E-ET educators on the use of educational technology in E-ET courses. Q Methodology has been chosen as the research method because it is designed to measure the participants’ subjectivity or views on a subject (Brown 1980, 1993; McKeown & Thomas, 1988).

The researcher will use Q methodology to investigate the views of the E-ET educators on the use of educational technology. A survey instrument will be used in conjunction with Q Methodology to gather information about the participants and their use of educational technology. The concourse, discussed in Chapter III, for this study includes interviews of E-ET educators that were conducted during the pilot study that is also discussed in Chapter III, general conversations with E-ET educators, post-sort interviews of the participants from the pilot study and a review of the literature. The Q-sample or Q statements that will be used for the Q-sort process for this study were derived from this concourse. This study will have a group of E-ET educators from at least one large Midwestern university perform a Q-sort and then use Q Methodology to conduct the analysis of the Q-sort. After the initial analysis is complete, the researcher will conduct follow up or post-sort interviews to help clarify the participants reasoning.
behind the specific statement placement in the Q-sort as well as to elicit any additional information that may arise post-sort.

Educational technology can be expensive for an institution to implement. The total cost of implementing educational technology includes the initial purchase, implementation, training and maintenance. The total of these costs can be quite high (Michko, 2007, 2008). There are many and varied areas of E-ET, each of which has its own specialized and sometimes advanced technologies. Because of the need exists for these specialized and advanced technologies in E-ET education already, the costs of adding educational technology may be yet more of a financial burden to E-ET departments than in other disciplines (Michko, 2008). Many E-ET departments spend large dollar amounts for specialized technologies that are specific to their field, yet the educators themselves seem to be reluctant to implement general educational technologies, such as clickers or on-line educational management systems into their lecture classrooms. Where the E-ET profession continues to make use of technology in the field, educators are slow to adapt their pedagogy to accommodate educational technology. As far back as 1985, the Haddad Report for the National Research Council's Committee on the Education and Utilization of the Engineer, recommended more use of technology to aid in the teaching of concepts in the E-ET educational (National Research Council Committee, 1985). In addition, there are at least three reports that call for a change in the teaching curriculum (BEST, 2004; National Academy of Engineering, 2004; National Academy of Engineering, 2005) and other studies that indicate that students are more engaged when educational technology is involved in higher education classrooms (Bowe, 2010). These reports and studies support the idea that the new technologies can be
important tools in increasing efficiency and effectiveness of E-ET education (Michko, 2007, 2008; Thomassian, Desai, & Kinnicut (2008); Bowe 2010). Vanasupa, et al., 2009 suggest that the twenty-first century challenges E-ET educators to design learning experiences to meet a variety of students needs in order better prepare future engineers for the skills needed to compete in our global market place, further supporting the argument of using educational technology in E-ET courses.

The question that needs to be asked is why are E-ET educators so slow to adopt and implement educational technology into their courses?

Investigating the views or subjectivity of E-ET educators may help to provide insight into the reluctance of E-ET educators into implementing educational technology. Q Methodology is a research method that offers researchers the ability to probe subjectivity or personal views. William Stephenson developed Q methodology as a means of measuring subjectivity (Brown 1980, 1993; McKeown & Thomas, 1988; Newman & Ramlo, 2010). Q Methodology allows participants to provide their personal perspectives by sorting items, typically statements related to the topic, into a grid. The analyses of the sorts include correlation and grouping of people with similar views or personal perspectives using factor analysis (Brown 1980; McKeown & Thomas, 1988; Ramlo, 2008; Ramlo & Nicholas, 2010). In other words, Q methodology is designed to determine groups (factors) whose attitudes are similar and to closely examine the groups (factors) whose attitudes are different (Brown 1980, 1993; McKeown & Thomas, 1988; ten Klooster, Visser, & de Jong, 2008).

Q Methodology is primarily an exploratory research technique that was developed in the 1930’s (Watts & Stenner, 2005). According to ten Klooster, et al. (2008), Q
Methodology was developed as an alternative to tests and scales, particularly when attitude measurement is at issue, as is the case in this study. Q Methodology displays many of the characteristics of mixed method research techniques in that it shares many of the focuses of qualitative research while utilizing the type of statistical analyses typically found in quantitative studies (Newman & Ramlo, 2010). Because the nature of this study is exploring the subjectivity, which can be defined as views or attitudes, regarding the use of educational technology by E-ET educators, Q Methodology is appropriate for this study.

Q Methodology offers researchers the opportunity to determine consensus and perspectives with in a group (Brown, 1980; 1993; McKeown & Thomas, 1988; Ramlo, 2008). In this case the group is E-ET educators. Q Methodology is concerned with the personal communication of a person’s point of view and as such is anchored in self-reference (Brown, 1980, 1993; McKeown & Thomas, 1988). Because of this focus on self-reference, Q Methodology enables the respondent to model his or her viewpoint on a subjective importance or importance to me (Brown, 1980, 1993; McKeown & Thomas, 1988). In the case of this study the subjective importance or importance to me will focus on use of educational technology by E-ET educators. Q Methodology holds promise to elicit why a participant believes what they do and not just what they believe. The study by ten Klooster, et al. (2008) provided support for the assumption that the Q-sort method reveals functional information that is not captured by standard Likert scale analysis. This study will use Q Methodology to investigate and examine E-ET educators’ views on the use of educational technology.

*The State of Engineering/Engineering Technology Education*
Undergraduate E-ET education is compromised of many disciplines, principally chemical, civil, electrical and computer, industrial and mechanical as well as other sub-disciplines (Michko, 2007, 2008). Engineering education adopted the engineering science model during the 1950’s as a reaction to the cold war. The engineering science education model moved away from the apprentice/hands on model that was prevalent before World War II and toward the lecture/teacher-centered model during this period (Kenyon, 1993; Michko, 2007, 2008). This teacher-centered model has also been called the chalk and talk method of teaching (Mills & Treagust, 2003). This lack of hands-on experience, particularly with the use of technology, has, in part, created a gap in what engineering professionals expect a graduate to do and what they are able to do (Michko, 2007, 2008).

Generally, once an E-ET student graduates and gets a job in industry, the employer spends 1 to 2 years to train the new engineer to be able to do real world Engineering (Wulf, 1998). This is a result of the E-ET education field not keeping pace with the changes in the industry (American Society for Engineering Education [ASEE], 1994; NRC BEE, 1995; National Science Foundation [NSF], 1995). The changes in the E-ET field include a reduction in the defense budget since the end of the cold war, the rise of global competition which led to restructuring of business, the growth of information technology among other factors (Michko, 2007, 2008). There are at least three reports that call for a change in the teaching curriculum (Building Engineering and Science Talent (BEST), 2004; National Academy of Engineering, 2004; National Academy of Engineering, 2005) and several studies that show that students are more engages when educational technology is used (Bowe, 2010). All three of these reports
intimate that new technologies, including educational technology, can be important tools in increasing efficiency and effectiveness of E-ET education.

The BEST (2004) report suggests that without breaking new ground in E-ET education to meet the challenges facing the twenty-first century engineer, America will not meet the talent imperative. The report targets the use of technology in the educational as one of the key areas to improve E-ET education. Because this report was focused on inclusion, it cited educational technology one option to increase inclusion and to teach to a variety of learning styles in the E-ET educational.

The National Academy of Engineering of the National Academies (2004, 2005) reports were designed specifically to target the issues currently facing E-ET education and to suggest methods of improvement. These reports ask what restructuring of programs, reallocation of resources, and refocusing of faculty time and energy are required so that E-ET educators can better educate E-ET and to provide them the conceptual understanding to tackle the problems of the future. The 2005 report states, in part, that with existing models, the United States is losing the battle for the imagination of our youth.

The National Academy of Engineering of the National Academies 2005 report discusses the fact the E-ET will be on the front line of any changes. Thus, encouraging and enlisting E-ET educators’ support for E-ET education innovations is essential. One of these education innovations is the use of educational technology (Bowe, 2010). This study aims to elicit what barriers, if any, exist to enlisting E-ET educators’ support for implementing educational technology by these educators. These reports state that increased attention to teaching and students’ learning are important for enriching the
undergraduate experience. To effect such changes E-ET faculty leaders, including deans, department chairs, and individual faculty must embrace this new paradigm.

The National Academy of Engineering of the National Academies 2005 report further suggests that there are opportunities afforded by both information technology and new technologies to address these issues. The report states that it may be possible to harness these technologies to transform education and training in ways previously unimaginable. Educational technologies that exist and those are coming could create rich and compelling learning opportunities that meet all learners’ needs, and provide knowledge and training when and where it is needed (Bowe, 2010).

The concern about E-ET education keeping pace with the world has existed for nearly three decades. By the end of the 1980’s there was growing concern that E-ET education was not changing in response to the changing world. By the 1990’s prominent leaders in E-ET education began questioning the limitations of the traditional E-ET disciplines (Lucena, 2003). These concerns resulted in the National Science Foundation’s (NSF) forming of the Engineering Education Coalitions (EEC). The goal of this coalition was to produce new structures and fresh approaches affecting all aspects of U.S. undergraduate E-ET education, including both curriculum content and significant new instructional delivery systems or educational technology (Lucena, 2003). More specifically the NSF/EEC report focused on developing methods of state-of-the-art of E-ET education. The findings of the report support development of a new E-ET curriculum using students working in teams rather than independently and including cooperative learning, especially in the earlier undergraduate years, increased use of contemporary educational technology, with computer-based methods of delivering courses increasingly
taking the place of traditional lectures (National Science Foundation, 2000). One of the
instructional methods the NSF (2000) recommends is just-in-time teaching.

Just-in-time is a teaching and learning strategy that combines in class learning
activities and the use of technology in the educational to enhance the learning activities
(Novak, Patterson, Gavrin &Christian, 1999). In the context of E-ET education, just-in-
time teaching is concurrent lecture and laboratory courses sequenced so that lecture
topics are covered just as they become needed in the laboratory. Traditionally, the lecture
and laboratory courses might have proceeded almost independently (National Science
Foundation, 2000). Educational technology offers E-ET educators a variety of new
instructional delivery systems to incorporate just-in-time teaching into their pedagogy, in
particular, the immediate feedback to gauge students’ conceptual understanding (Fies &
Marshall, 2006).

*Educational Technology*

Educational Technology also known as Classroom Technology and Instructional
Technology is defined for this study as computer-based technology, both hardware and
software, used in a classroom either by an instructor for teaching or a student for
learning. There are many products available in this category. Communications
technologies such as e-mail, audio and video conferencing, distance learning technology,
on-line classroom management programs, and the Internet offer increased accessibility
and communication options for both teachers and students (Michko, 2007, 2008). There
are also a number of in-class technologies available such as Classroom Response Systems
(clickers) (Fies & Marshall, 2006; Trees & Jackson, 2007; Kraft, 2008; Lasry, 2008,
Nicholas, 2010), on-line classroom management tools, tablet personal computers (TPC)
(Stickel & Hum, 2008), Digital Presentation Systems (often called ELMO’s, the name of the company that produces them) and interactive whiteboards also known as Smartboards that provide teachers with multimedia instructional options. Bebell & O'Dwyer (2004) report that 85% of K-12 teachers use a computer to develop instructional materials at home and 20% used the internet for posting assignments and homework. Michko (2007) found that of the over 21,000 articles that were reviewed regarding technology use in E-ET education, only 45 or 0.2% discussed the relationship between teaching and learning with technology in E-ET education, which indicates a gap between the use of educational technology in K-12 and E-ET education. Where the use of educational technology is becoming more widespread in K-12 it is not widely used in higher education including undergraduate and graduate E-ET education (Bowe, 2010). A review of the literature has revealed the use of educational technology in several areas of education is becoming more widespread, but the use of educational technology in undergraduate and graduate E-ET education has just recently begun to be explored.

Industry Standard Technology

Industry Standard Technology is defined for the purpose of this study as software packages such as MATLAB, AutoCAD, National Instruments Lab View, test equipment specific to a field of engineering and other technology that is common to the E-ET field. These technologies have typically been used in addition to the traditional lecture style of instruction or as standalone technology in laboratory experiments (National Science Foundation, 2002). Where these technologies are related the E-ET field for which they are designed, they differ from educational technology in that they are not designed specifically for educational use, but instead as a tool for the E-ET profession.
Discussion of the Use of Educational Technology in Engineering/Engineering Technology Education

E-ET education programs have often used similar technology tools that are found in industry or industry standard technology. Industry standard technology has traditionally been used in conjunction with traditional lecture style instruction often as standalone technology in laboratory experiments (National Science Foundation, 2002). Despite calls for implementing educational technology into undergraduate E-ET courses by BEST, ASEE, ABET and other influential organizations in the E-ET education field and studies indicating the engagement and effectiveness of educational technology (Fies and Marshall, 2006; Michko, 2007, 2008; Kraft, 2008; (Michko, 2007, 2008; Thomassian, et al., 2008; Nicholas, 2009, 2010b; Bowe 2010) there has been some reluctance to use educational technology in E-ET courses. Only recently has the implementation of educational technology become more widespread (Stickel & Hum, 2008).

Discussion of Technological Pedagogical Content Knowledge (TPACK)

Technological Pedagogical Content Knowledge (TPACK) is a theoretical framework that addresses the complex changes confronting educators who are moving beyond just integrating technology to deeper understanding of how technology can fundamentally change the practice and process of teaching and learning. Traditionally, research in the area of educational technology has often been critiqued for a lack of theoretical grounding. Where implementing technology in the educational can be a useful tool, the implementation of technology in the educational by itself is not sufficient to enhance learning. It is important to incorporate both effective pedagogy and content
knowledge along with the implementation of educational technology. TPACK focuses on how technology should be used in education and not if or what technology should be used (Mishra & Koehler, 2006).

Engineering education adopted the engineering science model during the 1950’s as a reaction to the cold war. The engineering science education model moved away from the apprentice/hands on model that was prevalent before World War II and toward the lecture/teacher-centered model during this period (Kenyon, 1993; Michko, 2007, 2008). This teacher-centered model has also been called the chalk and talk method of teaching and is still the predominate pedagogy being used in E-ET education today (Mills & Treagust, 2003). Developing an understanding of TPACK may help E-ET educator’s foster new strategies when transitioning from traditional teacher-centered lectures to teaching with educational technology. Most educators in higher education, including those in E-ET, did not learn using educational technology such as clickers or on-line educational management tools. During the time that higher education educators were students themselves, learning took place at desks, in traditional classrooms with teacher-centered lectures. It is important that the incorporation of educational technology does not become simply a lecture with a Power Point presentation, but that it is used to improve the learning experience for the student (Ward & Kushner Benson 2010). When newer technologies are considered, the arrival of these technologies may force educators to reconsider pedagogical and content issues. It stands to reason that there are also cases where good pedagogical practices will drive the content and technology decisions. All three factors of the TPACK framework affect the other and all three factors must be considered when using TPACK as a frame work for teaching (Mishra & Koehler, 2006).
Significance of the Study

The research on the views of E-ET educators’ use of educational technology is incomplete. Michko (2007, 2008) completed a meta-analysis on the use of teaching with technology in E-ET courses and found that empirical evidence on the relationship between teaching and learning with technology on student outcomes in undergraduate E-ET education is not extensive. Michko (2007) found that of the over 21,000 articles that were reviewed only 45 or 0.2% discussed the relationship between teaching and learning with technology in E-ET education. A review of the literature revealed only a few journal articles discussing the use of educational technology in E-ET courses (Michko, 2007, 2008; Benson, 2008; Stickel & Hum, 2008; Chen, Whittinghill & Kaldowec, 2010). This is largely due to the fact that E-ET education research is in its infancy (Michko, 2007, 2008). However, there have been a number of studies on the use of educational technology in the science classroom (Fies & Marshall, 2006; Trees & Jackson, 2007; Kraft, 2008; Lasry, 2008) as well as in other disciplines in higher education (Bowe, 2010). Given the parallels between science education and E-ET education, much of what has been learned from the science education research may also be applicable in the E-ET education field (Gunstone, 1994; Grimson, 2002; Hills & Tedford, 2003). Thus, more research must be done on the use of educational technology in E-ET courses.

One of the advantages of teaching with educational technology is that the teaching of abstract concepts can be easily enhanced through the use of animations (creating moving images for the purpose of demonstration of a concept), Java applets (used to provide interactive features from within another program), and complex graphics within Power Point presentations (Stickel & Hum, 2008). Where educational
technologies, such as clickers, have been integrated into the science education world (Kraft, 2008; Nicholas, 2009, 2010a), those same technologies have not yet been widely used in E-ET education. The relationships between science and E-ET have significant parallels with the relationships between science education and E-ET education. An example of these parallels is that science tends to see E-ET as applied science, the creative science or put another way E-ET are science based disciplines (Layton, 1976; Gunstone, 1994; Grimson, 2002; Hills & Tedford, 2003). In fact, ABET, Inc. (2011), which is the recognized accreditation organization for Engineering and Engineering Technology programs, defines engineering as “the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind.” In other words, those concepts learned from science are applied by E-ET’s in the field and thus are the same.

Because of these many parallels between science education and E-ET education, the use of educational technology in science education can be used as a template for research on clicker use in E-ET education. To date, there have been only two studies that the researcher has found that explore the views of the use of educational technology. Both of those studies focused on the views of the students (Kraft 2008; Nicholas 2009). Investigating the views of E-ET educators on the use of educational technology serves to identify what barriers, if any, exist into the implementation of educational technology. Discovering these barriers can help shape how to use educational technology in E-ET education to accomplish the stated learning objectives of a given course. The views of the
educators may prove useful when choosing what technology to use in E-ET education as well as how to use it tying theses views into the TPACK development.

**Research Questions**

1. What educational technology, if any, are engineering/engineering technology educators using in their courses?
2. If engineering/engineering technology educators are using educational technology how is it being used in the educational?
3. What are the various views E-ET educators have about educational technology and its use in their courses?
4. What is the relationship between the use of educational technology and the views of engineering/engineering technology educators regarding the use of educational technology in their engineering/engineering technology courses?

**Interview Process**

Q methodology displays many of the characteristics of mixed method research techniques in that it shares many of the focuses of qualitative research while utilizing the type of statistical analyses typically found in quantitative studies (Newman & Ramlo, 2010). One of the characteristics of qualitative research involves forming questions and asking them, also known as the interview process. The questions asked in interviews may be structured, semi-structured or open (Willis, 2007). The interview process for the pilot study included interviews with E-ET educators from a variety of E-ET disciplines. The interview participants included both those who are known to use educational technology and those who do not use educational technology. The questions were open ended,
designed to elicit the interviewee’s teaching style, to solicit the interviewee’s personal view on the use of educational technology in the E-ET educational, if educational technology is being used, what is being used and how it is it being used. The questions used are shown in Appendix 2. The interviews were then transcribed and used as part of the concourse to develop the Q statements. The statements were then used for the Q-sorting process in the pilot study described in Chapter III. Post-sort interviews were conducted with participants to clarify why they sorted the way they did. The information gathered from all of the aforementioned has been used to revise the Q statements with the goal of addressing the research questions:

1. What educational technology, if any, are engineering/engineering technology educators using in their courses?
2. If engineering/engineering technology educators are using educational technology how is it being used in the educational?
3. What are the various views E-ET educators have about educational technology and its use in their courses?
4. What is the relationship between the use of educational technology and the views of engineering/engineering technology educators regarding the use of educational technology in their engineering/engineering technology courses?

Delimitations

The researcher did not choose to consider the educators areas of specialty within the realm of E-ET education. Demographic information such as the race of the educator is not considered important to this study. Age, gender, time in-service, teaching load,
graduate status, institution and department may be considered in the final analysis. The views obtained in this study are not considered to be generalizable to the larger E-ET educator population as Q Methodology results are not considered to be generalizable to the larger population.

Definitions of Operational Terms

Age: the self-identification of educators’ current age, in years, at time of the study.

Engineering/Engineering Technology Educator: One who is a college level educator who engages in the practice of engineering and/or engineering technology education.

Engineering: focuses on applying the principles of mathematics and science, experience, judgment and common sense to make things which benefit people. In other words, engineering is the process of supplying a technical product to meet a specific need.

Engineering education: is the activity of teaching engineering at college and university levels.

Engineering Technology: focuses primarily on the applied aspects of science and engineering aimed at preparing graduates for practice in that portion of the technological spectrum closest to product improvement, industrial processes, and operational functions.

Engineering Technology Education: focus on application and practice. Engineering technology programs are characterized by their focus on application and practice, and by their approximately 50/50 mix of theory and laboratory experience.

Educational Technology: also known as Classroom Technology and Instructional Technology, is both hardware and software used in a classroom by an instructor for teaching, a student for learning, or both instructor and student.
Clickers: also known as Classroom Response Systems consist of individual handheld keypads that send a signal to a radio receiver that is connected to the instructor’s computer via USB.

On-Line Classroom Management System: Software packages that have special features such as discussion forums, calendars, and chat rooms where instructors and students can communicate in real time with each other, among other features such as quiz and polling capabilities.

Summary

The purpose of this study is to investigate the subjectivity of engineering and engineering technology educators at least one large, public Midwestern university on the use of educational technology in E-ET courses. The study includes interviews with E-ET faculty, development of a concourse for a Q-sort, analysis of the Q-sort results using Q methodology and follow up interviews of the Q-sort participants. This study aims to answer the following research questions:

1. What educational technology, if any, are engineering/engineering technology educators using in their courses?

2. If engineering/engineering technology educators are using educational technology how is it being used in the educational?

3. What are the various views E-ET educators have about educational technology and its use in their courses?

4. What is the relationship between the use of educational technology and the views of engineering/engineering technology educators regarding the use of educational technology in their engineering/engineering technology courses?
The purpose of this chapter is to present a comprehensive review of the literature related to this study. The literature review includes the topics of History of E-ET Education, Educational Technology, Discussion of Use of Technology and Educational Technology in engineering/engineering technology (E-ET) Education, Discussion of Technology Pedagogical Content Knowledge (TPACK), and Q Methodology.

General Background Information

Engineering and engineering technology education is comprised of many disciplines, principally chemical, civil, electrical industrial and mechanical as well as other sub-disciplines (Michko, 2007, 2008). Engineering education adopted the engineering science model during the 1950’s as a reaction to the cold war. The engineering science education model moved away from the apprentice/hands on model that was prevalent before World War II and toward the lecture/teacher-centered model during this period (Kenyon, 1993; Michko, 2007, 2008). This teacher-centered model has also been called the chalk and talk method of teaching (Mills & Treagust, 2003). This lack of hands-on experience, particularly with the use of technology, has, in part, created a gap in what engineering professionals expect a graduate to do and what they are able to do (Michko, 2007, 2008).

Generally, when an E-ET student graduates and gets a job in industry, the employer spends 1 to 2 years training the new engineer to be able to do real world E-ET
(Wulf, 1998). In part, this is a result of the E-ET education field not keeping pace with the changes in the E-ET industry. These changes include a reduction in the defense budget since the end of the cold war, the rise of global competition and the growth of information technology among other factors (Wulf, 1998; BEST, 2004; National Academy of Engineering, 2004; National Academy of Engineering, 2005; Michko, 2007, 2008).

There are at least three reports that call for a change in the teaching curriculum (BEST, 2004; National Academy of Engineering, 2004; National Academy of Engineering, 2005) as well as a recent study of 175 higher education faculty members where 60% of the faculty members reported that their students appeared more engaged when educational technology was used (Bowe, 2010). All of this indicates that educational technologies can be important tools in increasing the efficiency and the effectiveness of E-ET education.

Chickering and Gamson (1987) state there are seven principles for good practice in undergraduate education. They are:

1. Encourages Student-Faculty Contact.
2. Encourages Cooperation among Students.
3. Encourages Active Learning.
5. Emphasizes Time on Task.
Chickering and Erhmann (1996) expanded on the seven principles by suggesting how to use technology to implement the seven principles. Communications Technologies such as e-mail, audio and video conferencing, distance learning technology, (Michko, 2007, 2008), clickers (Fies & Marshall, 2006; Kraft, 2008), on-line course management programs (Nicholas, 2009, 2010), and the internet offer the most convenient options. These technologies can offer prompt feedback for the instructor, encouragement of active learning for the student, increase accessibility and encourage student-faculty contact. The implementation of these technologies along with the seven principles for good practice offer E-ET educators the opportunity to increase time on task, ability to offer different material at different speeds to accommodate a variety of learning styles, and to more clearly articulate the expectations of the class among other benefits. Students may also be motivated by the ease of communication with other students and the instructor that online course management tools can offer (Chickering and Erhmann, 1996).

The current thinking in educational psychology is that the learner is the ultimate regulator of the learning process (Vanasupa, Stolk & Hertler, 2009). Recent studies have shown students’ views of educational technology in science and engineering technology courses is largely positive (Kraft 2008; Nicholas 2009). In order to better prepare their students for the world in which they will work, universities cannot afford to ignore technology as an educational tool (Bowe 2010). All of these studies support the argument of the need for wider use of educational technology in E-ET courses.

*History of Engineering/Engineering Technology Education*

During the 19th century and the early part of the 20th century, a mixture of theory and practice defined engineering education in the United States. The Morrill Land Grant
Act of 1862 provided federal land to states to build public universities. These universities became the vehicles through which engineering education, defined as a combination of school education and practical training, became widely available to students in the United States (Lucena, 2003). In 1893, the Society for the Promotion of Engineering Education was formed. It was the first society formed specifically to support the education of a profession, preceding those for both law and medicine (Lucena, 2003; Michko, 2007, 2008). Formal engineering education was not considered useful for the practicing engineer at that time. The emphasis on science in the engineering curriculum was not yet the choice of engineering educators. Workshop practice and the apprenticeship style of education remained a significant part of what constituted engineering knowledge into the 20th century, the model would be revised as a blend of engineering science and hands-on laboratories. This model was renamed engineering technology in the 1960’s (Lucena, 2003).

As the 20th century progressed, and especially after World War I and World War II, corporations emerged as the main employer of engineers. The beginning of the cold war and the space race shifted the focus of engineering education to the engineering science model in engineering education (Lucena, 2003; Michko, 2007, 2008). During the decade of 1980’s, fear of Japanese competitiveness emerged and caused concern about the number of engineers being graduated in the United States versus Japan. This resulted in initiatives for recruitment and retention of E-ET students, but E-ET curriculum remained largely unchanged.

By the end of the 1980’s there was growing concern that E-ET education in the United States was not changing in response to the changing world. By the 1990’s
prominent leaders in E-ET education began questioning the limitations of the traditional E-ET disciplines. These concerns resulted in the National Science Foundation’s (NSF) forming of the Engineering Education Coalitions (EEC) whose goal was to produce new structures and fresh approaches affecting all aspects of U.S. E-ET education, including both curriculum content and significant new instructional delivery systems (Lucena, 2003).

*Educational Technology*

Educational Technology also know as Classroom Technology and Instructional Technology is defined for this study as computer-based technology, both hardware and software, used in a classroom either by an instructor for teaching or a student for learning. There are many products available in this category. Communications technologies such as e-mail, audio and video conferencing, distance learning technology, (Michko, 2007, 2008), and the internet offer increased accessibility and communication options for both teachers and students. There are also a number of in-class technologies available such as Classroom Response Systems (clickers) (Fies & Marshall, 2006; Kraft, 2008; Nicholas, 2009, 2010), on-line course management tools (Nicholas, 2009, 2010) tablet personal computers (TPC) (Stickel & Hum, 2008), Digital Presentation Systems (often called ELMO’s, the name of the company that produces them) and interactive whiteboards also known as Smartboards that provide instructors with multimedia instructional options. There are also an increasing number of software packages becoming available for use with these hardware options such as MessageGrid for TPC’s (Stickel & Hum, 2008) and Classroom Performance System (CPS) by eInstruction that is used with clickers. Clickers using CPS and TPCs using MessageGrid offer the student the
ability to anonymously participate in classroom discussions and the instructor immediate
feedback on the effectiveness of instruction by asking well constructed questions about
the lecture material (Fies & Marshall, 2006; Kraft, 2008; Stickel & Hum, 2008; Nicholas,
2009, 2010).

Bebell et al. (2004) report that 85% of K-12 teachers use a computer to develop
instructional materials at home and that 20% used the internet for posting assignments
and homework. Where the use of educational technology has become more widespread in
K-12 it is not widely used in undergraduate E-ET education (Bowe, 2010). The literature
review revealed that the use of educational technology has only begun to find its way into
E-ET education (Michko, 2007, 2008; Stickel & Hum, 2008). This is due, in part, to
some aversion to implementing educational technology in E-ET courses by E-ET
educators (Bowe, 2010).

Discussion of the Use of Technology and Educational Technology in
Engineering/Engineering Technology Education

E-ET education programs have often used similar technology tools that are found
in industry or industry standard technology. Industry standard technology has
traditionally been used conjunction with traditional lecture style instruction often as
standalone technology in laboratory experiments (National Science Foundation, 2002).
Despite calls for implementing educational technology into undergraduate E-ET courses
by BEST, ASEE, ABET and other influential organizations in the E-ET education field
and studies indicating the engagement and effectiveness of educational technology (Fies
and Marshall, 2006; Michko, 2007, 2008; Kraft, 2008; Nicholas, 2009; Bowe 2010) there
has been some reluctance to use educational technology in E-ET courses. Only recently
has the implementation of educational technology is become more widespread (Stickel & Hum, 2008). Vanasupa, et al., 2009 suggest that the twenty-first century challenges E-ET educators to design learning experiences to meet a variety of students needs in order better prepare future engineers for the skills needed to compete in our global market place. Educational Technology offers E-ET educators an opportunity to redesign their courses to accomplish this goal.

Only recently has the implementation of educational technology is become more widespread in E-ET courses. One example of the implementation of educational technology in E-ET is the use of the tablet PC (TPC), which is becoming a popular tool for E-ET education (Stickel & Hum, 2008). An example of how the TPC is being used E-ET courses occurred at The Massachusetts Institute of Technology (MIT). Faculty there used a Tablet-PC-based system called Classroom Learning Partner (CLP) to support in-class assessment in a computing class. Students wirelessly submitted digital ink answers to in–class questions to the instructor, allowing the instructor to display correct answers, provide feedback and address student misunderstandings when they occurred (Cromack, 2008). TPCs allow the instructor to combine the advantages of a PowerPoint type presentation with the interactivity of the standard blackboard approach. The teaching of abstract concepts can be easily enhanced through the use of animations, Java applets, and complex graphics (Stickel & Hum, 2008; Cromack, 2008) clickers offer similar benefits.

Other uses of the TPC in an engineering classroom involve the use of web-based software tools designed for interactivity in the classroom. An example of such a program is called MessageGrid, developed by Roy P. Pargas of Clemson University, which
enables an instructor to interact electronically with the students in or out of class. The advantages of such software packages include increased accessibility and the ability to allow students to respond anonymously (Benson & Pargas, 2008).

Another example of using educational technology is found in the use Classroom Response Systems (CRS’s or clickers). Clickers consist of transmitters that students use to send responses and receivers that are connected to a computer that collect these responses. The computer runs software designed to interpret and aggregate these responses in real time (Fies & Marshall, 2006; Kraft, 2008; Nicholas, 2009, 2010a). The instructor has a choice as to how publicly or how anonymously the student responses are collected and displayed. The aggregated responses are almost always publicly displayed to inform both instructors and learners of the overall distribution of selections in a classroom (Fies & Marshall, 2006). Educational technologies, such as clickers, have found their way into the science education world, but have not yet been widely used in E-ET education. Some recent studies on students’ views of the use of educational technology, specifically clickers and on-line course management systems, have been conducted using Q-methodology (Kraft, 2008; Nicholas, 2009). Those studies suggest that students respond positively to the use of clickers and on-line course management systems, in science and engineering technology courses. The relationships between science and E-ET have significant parallels with the relationships between science education and E-ET education. The most obvious example of this is that just as science tends to see E-ET as applied science, the creative science or put another way, E-ET are science based disciplines (Layton, 1976; Gunstone, 1994; Grimson, 2002; Hills & Tedford, 2003). These parallels are further supported by Layton’s (1976) description of
engineering as the creative science. Layton (1976, p. 690) cites Thomas C. Clarke, then
president of the American Society of Engineers, in 1896 as stating “science is the
discovery and classification of the laws of nature. Engineering ... is the practical
application of such discovered laws.” In fact, ABET, Inc. (2011), which is the
recognized accreditation organization for Engineering and Engineering Technology
programs, defines engineering as “the profession in which a knowledge of the
mathematical and natural sciences gained by study, experience, and practice is applied
with judgment to develop ways to utilize economically the materials and forces of nature
for the benefit of mankind.” The parallels between science and engineering are
recognized by both scientists and engineers alike. It is because of the many parallels
between science education and E-ET education, the use of educational technology in
science education can be used as a template for educational technology use in E-ET
education.

Discussion of Technological Pedagogical Content Knowledge (TPACK)

Predominately, the pedagogy currently found in E-ET education is the
engineering science model developed during the 1950’s as a reaction to the cold war. The
engineering science education model moved away from the apprentice/hands on model
that was prevalent before World War II and toward the lecture/teacher-centered model
during this period (Kenyon, 1993; Michko, 2007, 2008). This teacher-centered model has
also been called the chalk and talk method of teaching (Mills & Treagust, 2003).
Educational technology offers E-ET educators the opportunity to move beyond that
traditional model and increase student engagement (Mills & Treagust, 2003; Bowe, 2010;
Nicholas, 2010a). Technological Pedagogical Content Knowledge (TPACK) is a
theoretical framework that addresses the complex changes confronting educators who are moving beyond simply integrating technology into their courses to deeper understanding of how technology can fundamentally change the practice and process of teaching and learning (Mishra & Koehler, 2006; Ward & Kushner Benson, 2010). Where implementing technology in the course can be a useful tool, the implementation of technology in the course by itself is not sufficient to enhance learning. It is important to incorporate both effective pedagogy and content knowledge along with the implementation of educational technology (Mishra & Koehler, 2006; Ward & Kushner Benson, 2010). TPACK focuses on how technology should be used in education and not if or what technology should be used.

In the past, studies of teacher education have focused on the content knowledge of the teacher. The trend in teacher education has recently shifted its focus to pedagogy, emphasizing general pedagogical classroom practices independent of subject matter and often at the expense of content knowledge. Dr. Lee S. Shulman, in the mid-1980’s, introduced the idea of Pedagogical Content Knowledge (PCK), claiming that the emphases on teachers’ subject knowledge and pedagogy were being treated as mutually exclusive domains (Mishra & Koehler, 2006).

Shulman proposed considering the necessary relationship between the two by introducing the concept of PCK. PCK is defined as that which exists at the intersection of content and pedagogy. Shulman argues that it goes beyond a simple consideration of content and pedagogy in isolation, but that PCK represents the blending of content and pedagogy into an understanding of how particular aspects of subject matter are organized, adapted, and represented for instruction (Mishra & Koehler, 2006).
Figure 1. The Two Circles Representing Pedagogical and Content Knowledge in isolation.

Figure 2. The two circles of Pedagogical Knowledge and Content Knowledge are now joined by pedagogical content knowledge.

Since Dr. Shulman’s ground breaking work, the use of educational technology has become increasingly popular in the world of education and thus introduced another dynamic into the PCK model (Mishra & Koehler, 2006). Mishra and Koehler take Dr. Shulman’s work one step further by introducing technology use into the model. They call this new model Technological Pedagogical Content Knowledge (TPCK) which represents the blending of content, pedagogy and technology.

Mishra and Koehler noticed that current discussions of the role of technology knowledge seem to share many of the same problems that Shulman identified back in the
1980s while looking at content and pedagogy knowledge. Prior to Shulman’s work on PCK, knowledge of content and knowledge of pedagogy were considered separate and independent from each other. Similarly, knowledge of technology is often considered to be separate from knowledge of pedagogy and content (Mishra & Koehler, 2006). Figure 3 depicts the PCK circle overlapping with the technology circle outside of the two. This represents how the use of technology is currently viewed in many cases. Figure 4 represents TPACK as the overlapping circles. The intersection of the three circles is where TPACK exists.

Figure 3. The Three Circles Represent Pedagogy, Content, and Technology Knowledge. Content and Pedagogy Overlap to Form Pedagogical Content Knowledge While Technology Is Seen as Being a Separate and Independent Knowledge Domain.
Figure 4. Pedagogical Technological Content Knowledge. The Three Circles, Content, Pedagogy, and Technology, Overlap to Lead to Four More Kinds of Interrelated Knowledge.

The work done by Shulman produced only one set of knowledge intersections called pedagogical content knowledge (PCK), Mishra and Koehler’s TPACK produces three pairs of knowledge intersections pedagogical content knowledge (PCK), technological content knowledge (TCK) and technological pedagogical knowledge (TPK) and one triad knowledge intersection (TPCK) (Mishra & Koehler, 2006). Technological content knowledge (TCK) focuses on how the subject matter can be changed by the application of technology. Technological pedagogical knowledge (TPK) focuses on the capabilities of various technologies and how teaching might change by using these technologies. Technological pedagogical content knowledge (TPCK) requires an understanding of the representation of concepts using technologies and pedagogical techniques that use technologies in constructive ways to teach content (Mishra & Koehler, 2006; Ward & Kushner Benson, 2010).

Ultimately, TPCK is knowledge that is important to teachers working with technology. It is knowledge that would not necessarily be held by those who are
technologically proficient subject matter experts or by technologists who know little about pedagogy or by those with knowledge of pedagogy who know little of the subject matter or technology (Mishra & Koehler, 2006). It is a working knowledge of all three (technology, pedagogy and content) and how they work together.

Traditionally, content has driven the decisions of the pedagogical goals and what technology is to be used. However, when newer technology is considered, the arrival of this new technology may force educators to reconsider pedagogical and content issues (Mishra & Koehler, 2006; Ward & Kushner Benson, 2010). It stands to reason, then, that there are also cases where good pedagogical practices will drive the content and technology decisions. All three factors affect the other and all three factors must be considered when using TPCK as a framework for teaching. Thus, an understanding of the TPACK framework may be significant in helping higher education and, in particular, E-ET educators make the transition from the traditional lecture style of teaching to introducing educational technology into their pedagogy (Ward & Kushner Benson, 2010).

Q Methodology

Developed by psychologist William Stevenson in the 1930’s, Q Methodology, also called the Q-sorting technique, or simply Q, allows researchers to identify, both quantitatively and qualitatively, the various opinions within a group and the number of people within the group who hold these opinions. Q methodology is an appropriate choice whenever a researcher wishes to determine the various perspectives and consensus within a group regarding any topic. Q Methodology provides the researcher a systematic and rigorously quantitative means for examining human subjectivity by encompassing a distinctive set of psychometric and operational principles that are coupled with
specialized statistical applications of correlational and factor-analysis techniques. The first step in using Q Methodology is to develop the concourse.

The concourse, which is used to develop the set of statements to be sorted, can be developed using a variety of techniques including participant interviews or from existing sources such as media outlets. The concourse is followed by a selection, called the Q-sample that the participants will be asked to sort (Brown 1980, 1993; McKeown & Thomas, 1988; Ramlo, 2008). The participants are then asked to pre-sort the items, typically statements on numbered strips of paper, into three categories, most like my view, neutral and least like my view. Once this pre-sorting has been completed, participants physically sort items, relative to each other into a normalized or Gaussian distribution onto a grid (Ramlo, 2008; Ramlo & Nicholas, 2009).

Q Methodology is similar to the Likert survey scale in that the distribution on the grid typically ranges from least like my view to most like my view. However, it differs from Likert scale surveys in that Q involves participants physically sorting items relative to each other into a normalized or Gaussian distribution based upon that participant’s opinion within a particular setting, known as the condition of instruction (Brown 1980, 1993; McKeown & Thomas, 1988; Ramlo, 2008; Ramlo, 2008; Ramlo & Nicholas, 2009) such as the grid presented in Figure 5 below.
The sorting process alone, however, does not represent the entire process of Q methodology. This is a common misinterpretation of this methodology. Q Methodology was created for the study of behavior by implicitly using the combination of the Q-sort process and the pattern analysis that utilizes correlation and factor analysis. It is this combination that allows Q Methodology to be a measure of subjectivity. The sorting process alone or the sorting process used with other types of analyses is not Q methodology but, instead, a misinterpretation of Q methodology (Ramlo, 2008; Ramlo & Nicholas, 2009).

Once the sorts have been conducted by the participants, the analysis of the data must be conducted. The analyses of the Q-sorts involve correlation, factor loadings, factor analysis, and the calculation of factor scores. Factor loadings are simply correlation coefficients. The higher the factor loading, the more highly the sorter is correlated with that factor or view. Those sorters with similar views are more highly correlated with the same factor. The recommended factoring procedure (Newman & Ramlo, 2010) includes
centroid extraction (data reduction) with hand rotation because this allows the researcher to investigate factors based upon theoretical considerations. Several programs created specifically to handle the type of data collection and analyses in Q exist. PQ Method is one of the most common and is available for free (Ramlo, 2008).

The major concern of Q methodology is not with how many people subscribe to a particular belief, but with why they believe what they do. In R-based research, perspective is external. Because of this external perspective and the initial uncertainty of R-based researchers that the respondents’ frame of reference is correctly understood, specific person-sampling procedures and large sample sizes are necessary in order to control for measurement error. On the other hand, with Q methodology small sample sizes, including single case studies, are psychometrically acceptable because the observational perspective is the respondents own (McKeown & Thomas, 1988). This means that any observations or interpretive accounts that are advanced by the researchers are subservient to the respondent’s frame of reference as made operant by Q-sorting. Because of this, the validity and reliability tests that are so important in mainstream convention research are unessential within the psychometric framework of Q Methodology (Brown 1980, 1993; McKeown & Thomas, 1988).

The factor loadings express the extent to which each Q-sort is associated with each factor. With little exception, only the first two or three factors contain significant loadings, although it is possible that more than three factors may emerge (Brown, 1980; 1993). However, the original set of factors is the raw materials from which the probing of these subjective relationships can take place from the vantage points of interest (Brown, 1980, 1993, 2009; McKeown & Thomas, 1988; Newman & Ramlo, 2010). Because the
use of factor rotation allows the researcher to take advantage of any insights, prior knowledge, hunches, guesses and hypotheses that the researcher may have, Peirce’s theory of abduction is inherent in Q Methodology (Brown, 1980, 1993, 2009; McKeown & Thomas, 1988).

Abduction, which is defined as the process of arriving at an explanatory hypothesis, is a theory forwarded by Charles Peirce, although he borrowed the term from Aristotle (Walsh, 1972). Peirce drew a distinction between induction and abduction. He referred to induction as the descriptive, summarizing part of science and abduction as the explanatory, theoretical part. To rephrase, Pierce described induction as an inference from a sample to a whole, while he described abduction as an inference from a body of data to an explaining hypothesis (Walsh, 1972). Thus, Q methodology being exploratory in nature is tied closely to Pierce’s Theory of abduction.

Q Methodology may be guided by what Stephenson referred to as the abductive principles. In other words, the researcher uses factor analysis as a probe into Nature’s possibilities (abduction) as opposed to a passive finder of Nature’s truths (induction) (Brown, 1980, 1993). Using centroid factor analysis and hand rotation was the preferred method of William Stephenson because this combination allows the researcher the best opportunity to apply these abductive principles (Newman & Ramlo, 2010). There are, however, an infinite number of ways in which the factors can be rotated (Varimax and hand rotation being only two). In any case, the abductive principles allow the researcher to probe these analyses exploring any preconceived ideas, vague notions, and/or prior knowledge about the study or participants, while at the same time giving due regard for any obvious contours or patterns in the data themselves (Brown, 1980, 1993).
The psychometrics of Q Methodology call for correlation and factoring of persons as opposed to R-method or mainstream research, where the test, traits and the like are correlated and factored. Where this distinction is accurate, many have misinterpreted the persons versus traits distinction to mean that Q Methodology is simply and inverted Q-factor analysis: that it is nothing more than a modification of the application of R-method factoring. If that were the case, the correlations and factors produced would have little practical meaning (Brown, 1980, 1993; McKeown & Thomas, 1988). The factoring of persons within Q Methodology means that the observations are premised on a common unit of measurement which Stephenson called self-significance. The traits that compose a Q-data matrix are centered about a mean of psychological significant to the respondent, namely, importance to me (Brown 1980, 1993; McKeown & Thomas, 1988). Once the Q sorts have been collected, the mathematics of correlation and factoring are identical to that of R-method applications.

Summary

E-ET education is compromised of many disciplines, principally chemical, civil, electrical, industrial and mechanical as well as other sub-disciplines (Michko, 2007, 2008). Engineering education adopted the engineering science model during the 1950’s as a reaction to the cold war. The engineering science education model moved away from the apprentice-hands on model that was prevalent before World War II and toward the teacher-centered lecture model during this period (Kenyon, 1993; Michko, 2007, 2008).

Generally, when an E-ET student graduates and gets a job in industry, the employer spends one to two years training the new engineer to be able to do real world engineering/engineering technology (Wulf, 1998). In part, this is a result of the E-ET
education field not keeping pace with the changes in the industry. These changes include a reduction in the defense budget since the end of the cold war, the rise of global competition and the growth of information technology among other factors (Wulf, 1998; BEST, 2004; National Academy of Engineering, 2004; National Academy of Engineering, 2005; Michko, 2007, 2008).

There are at least three reports that call for a change in the teaching curriculum (BEST, 2004; National Academy of Engineering, 2004; National Academy of Engineering, 2005) as well as a recent study of 175 higher education faculty members where 60% of the faculty members reported that their students appeared more engaged when educational technology was used (Bowe, 2010). All of this indicates that the new technologies can be important tools in increasing efficiency and effectiveness of E-ET education.

E-ET education programs have often used similar technology tools that are found in industry or industry standard technology. Industry standard technology has traditionally been used conjunction with traditional lecture style instruction often as standalone technology in laboratory experiments (National Science Foundation, 2002). Despite calls for implementing educational technology into undergraduate E-ET courses by BEST, ASEE, ABET and other influential organizations in the E-ET education field and studies indicating the engagement and effectiveness of educational technology (Fies and Marshall, 2006; Michko, 2007, 2008; Kraft, 2008; Nicholas, 2009; Bowe 2010) there has been some reluctance to use educational technology in E-ET courses.

Only recently has the implementation of educational technology is become more widespread. But it is not enough to simply implement these technologies into the course.
It is crucial that these technologies intertwine with the content and pedagogy. An emerging theory called Technological Pedagogical Content Knowledge (TPACK) can be used in part to resolve this issue (Mishra & Koehler, 2006).

Technological Pedagogical Content Knowledge (TPACK) is a theoretical framework that addresses the complex changes confronting educators who are moving beyond just integrating technology to deeper understanding of how technology can fundamentally change the practice and process of teaching and learning. Traditionally, research in the area of educational technology has often been critiqued for a lack of theoretical grounding (Mishra & Koehler, 2006). Where implementing technology in the course can be a useful tool, the implementation of technology in the course by itself is not sufficient to enhance learning. It is important to incorporate both effective pedagogy and content knowledge along with the implementation of educational technology. TPACK focuses on how technology should be used in education for the development of knowledge and not if or what technology should be used. However, before TPACK can become widespread in E-ET education, barriers to implementing educational technology within the E-ET education community must be discovered. A research methodology call Q-Methodology offers the best solution to discovering these barriers.

Q Methodology allows researchers to identify, both quantitatively and qualitatively, the various opinions within a group and the number of people within the group who hold these opinions. Q methodology, or simply Q, is an appropriate choice whenever a researcher wishes to determine the various perspectives and consensus within a group regarding any topic (Brown, 1980, 1993; McKeown & Thomas, 1988; Ramlo, 2008; Brown & Good, 2010). Q Methodology provides the researcher a systematic and
rigorously quantitative means for examining human subjectivity by encompassing a distinctive set of psychometric and operational principles that are conjoined with specialized statistical applications of correlative and factor-analysis techniques (McKeown & Thomas, 1988). Using Q Methodology to investigate the views of the use of educational technology of E-ET educators offers an opportunity to illuminate some of the reasons why the reluctance to implementing educational technology into E-ET education courses exists.
CHAPTER III

PROCEDURES

This chapter includes the general derivations of the general and specific research hypotheses followed by the variable list and the hypotheses. Other sections include the participants, sampling procedures a discussion of the research design used in this study as well as a discussion of the method used, Q Methodology. The instrument section includes a discussion of a pilot study conducted during the spring 2010 semester to investigate the views of the use of educational technology in engineering/engineering technology (E-ET) education by E-ET educators. The statistical treatment section discusses Q Methodology, the statistical method used for this study.

Derivation of General Research Hypotheses and Specific Research Hypotheses

Despite the potential to improve the pedagogy in E-ET education by implementing educational technology into E-ET courses, there is a high level of resistance toward doing so by engineering educators (Michko, 2007, 2008). Educational technology can be expensive for an institution to implement. Because of the need for both specialized and advanced technologies in E-ET education these costs may be yet more expensive than in other disciplines. If one were to include the purchase, implementation, training, and maintenance, the costs the cost of implementing educational technology may put addition strain on departmental budgets (Michko, 2007, 2008).

There are many areas of E-ET, each of which has its own specialized and sometimes advanced technologies. Many E-ET departments will spend large dollar
amounts for these specialized technologies (Michko, 2008) yet the educators themselves seem to be reluctant to implement general educational technologies, into their traditional lecture classrooms. Where the E-ET profession continues to make use of technology in the field, educators are slow to adapt their pedagogy to accommodate educational technology. Most educators in higher education, including those in E-ET, did not learn using educational technology such as clickers or on-line course management tools (Ward & Kushner Benson 2010). During the time that current educators in higher education were students themselves, learning took place at desks, in traditional classrooms with instructor-focused lectures (Ward & Kushner Benson 2010). This generational gap in teaching and learning styles has resulted in many educators seeing little value in teaching with technology and they often view educational technology it as just another educational trend (Bowe, 2010).

No studies were found in the literature review that directly investigated the views of E-ET educators on the use of educational technology. Bowe’s 2010 dissertation conducted a five year study on higher education educators’ use and views of educational technology.

Education in all disciplines has changed in recent years. While students seem drawn to technologies and educators appear to be aware of these technologies, they aren’t necessarily moved to use them in their courses (Bowe, 2010). The researcher generated the following general and specific research hypotheses, below.
**General & Specific Research Hypotheses**

**General Research Hypothesis 1**
Exploring the types of educational technology engineering/engineering technology educators use will reveal that a variety of educational technology is being used in the engineering/engineering technology courses.

**Specific Research Hypothesis 1A**
The survey instrument will reveal what types of educational technology are being used in engineering/engineering technology courses.

**Specific Research Hypothesis 1B**
The survey instrument will reveal how educational technologies are being used in engineering/ engineering technology courses.

**General Research Hypothesis 2**
The analysis of the Q-sort will reveal the different views on the use of educational technology that exist among engineering/engineering technology educators who use educational technology and those who do not use educational technology.

**Specific Research Hypothesis 2A**
The views on the use of educational technology of the engineering/engineering technology educators who use educational technology will differ from those who do not use educational technology.

**Specific Research Hypothesis 2B**
The views on the use of educational technology of the engineering educators will differ from engineering technology educators.

**Research Questions**

46
1. What educational technology, if any, are engineering/engineering technology educators using in their courses?

2. If engineering/engineering technology educators are using educational technology how is it being used in the course?

3. What are the various views E-ET educators have about educational technology and its use in their courses?

4. What is the relationship between the use of educational technology and the views of engineering/engineering technology educators regarding the use of educational technology in their engineering/engineering technology courses?

**Participants**

*Engineering/Engineering Technology Educators*

Engineering education is defined as the activity of teaching engineering at the college and university level preparing the graduate for a profession as a practicing engineer. Engineering Technology education is defined as the activity of teaching engineering technology at the college and university level focusing primarily on the applied aspects of science and engineering. Engineering Technology education prepares graduates for practice in that portion of the technological spectrum closest to product improvement, industrial processes, and operational functions (ABET, 2010). Despite these differences in focus, the concepts taught in E-ET are the same in the respective disciplines (e.g. Electrical Engineering and Electrical Engineering Technology). E-ET educators are those who teach E-ET at the undergraduate and graduates levels. The demographic information is listed in Table 1 below.
Table 1

Demographic Information

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Participants Contacted</td>
<td>19</td>
<td>100%</td>
</tr>
<tr>
<td>Number of Participants Who Responded</td>
<td>14</td>
<td>74%</td>
</tr>
<tr>
<td>Engineering Educators</td>
<td>4</td>
<td>29%</td>
</tr>
<tr>
<td>Engineering Technology Educators</td>
<td>10</td>
<td>71%</td>
</tr>
<tr>
<td>Male</td>
<td>12</td>
<td>86%</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>14%</td>
</tr>
<tr>
<td>White Males</td>
<td>9</td>
<td>64%</td>
</tr>
<tr>
<td>Non-White Males</td>
<td>3</td>
<td>21%</td>
</tr>
<tr>
<td>White Females</td>
<td>2</td>
<td>14%</td>
</tr>
<tr>
<td>Age</td>
<td>37-66</td>
<td>N/A</td>
</tr>
<tr>
<td>Age</td>
<td>53.7</td>
<td>N/A</td>
</tr>
<tr>
<td>Years in Service</td>
<td>2-33</td>
<td>N/A</td>
</tr>
<tr>
<td>Years in Service</td>
<td>17</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Among E-ET faculty there are few minority full professors E-ET disciplines the highest percentage of all minorities combined among full professors is less than 5% and that was in the chemical engineering discipline (Nelson, 2007). Participants for the pilot study were recruited for a large Midwestern university that includes both engineering and engineering technology programs, all of which are ABET accredited. The participants were from the following disciplines: Electrical Engineering, Electronic Engineering Technology, Civil Engineering, Construction Engineering Technology, Surveying Engineering Technology, Mechanical Engineering Technology, and Automated
Manufacturing Engineering Technology. There were 19 participants total, 14 who
returned the DETUS and the Q-sort which equated to a 74% response rate.

Of the 14 who returned the survey and Q-sort, four (29%) of the participants were
ingengineering educators and ten (71%) were engineering technology educators. Twelve
(86%) of the participants were male and two (14%) were female. Breaking down the
demographics of the study by race, nine (64%) of the participants were white males, three
(21%) were non-white males and two (14%) were white females. Based upon the
demographic information available from the Nelson (2007) study, the participants from
the pilot study reflect the demographics of the E-ET education field. The ages of the
participants ranged from 37 years to 66 years, with a mean age of 53.7 years. The time in
service of the participants (years working as an engineering/engineering technology
educator) ranged from 2 years to 33 years, with a mean of 17 years of service. The
participants taught both undergraduate and graduate level courses in the aforementioned
E-ET disciplines.

Because this study is a revised version of the pilot study where the DETUS was
expanded from the survey used in the pilot study and some of the Q- statements were
changed based on the result and post-sort interviews of the pilot study, some of the
participants from the pilot study were also recruited for this study. The participant
selection was conducted to insure that the participants are representative of a variety of E-
ET disciplines, gender, age, and use/non-use of educational technology.

_Sampling Procedures_

The research method for this study is Q Methodology. In this methodology, the
Q-sample that the participants are asked to sort is the sample for the study. The Q-sample
is intended to get at patterning within individuals (case-wise) as opposed to simply across individuals (also known as factor-wise sorting). Q Methodology uses an ipsative technique of sorting a representative set of subjective statements drawn from a concourse of possible feelings or reactions about a subjective condition. Thus, in Q Methodology, the number of participants is of lesser importance than in quantitative statistical considerations. The participants are chosen by the researcher such that they have some knowledge or interest in the subjectivity being studied. Once chosen, participants are the person set or p-set.

Participants are then asked to rank-order the statements from their point of view, according to some preference, judgment or feeling about the statements (Brown, 1980, 1993; Van Exel, 2005; Ramlo & Nicholas, 2009). The set of statements can be developed using a variety of techniques including participant interviews, from existing sources such as media outlets or any of the other methods involved in the concourse development (Ramlo & Nicholas, 2009). Similar in a sense to the process of sampling persons in survey research, the primary goal of selecting a Q-sample is to yield statements that represent the larger process being modeled without losing its comprehensiveness (Brown, 1980, 1993). In this study the researcher developed the Q-sample from the interviews conducted for the pilot study, conversations with E-ET educators, a review of the literature and from post-sort interviews conducted with the participants of the pilot study. These Q statements were administered to the participants who in turn performed the Q-sort. The participants whose views are similar loaded on the same factor. These factors were used to determine what views on the use of educational technology in the E-ET course exist.
Research Design

A research design where there is no treatment involved is a priori research. Typically, an a priori design is used when analytic methods do not exist for the goal of interest, in this case the views of E-ET educators on the use of educational technology (Kelley, 2010).

A priori research design

An a priori research design is an appropriate research design for exploratory research (Salkind, 2010). Typically, an a priori design is used when analytic methods do not exist for the goal of interest, in this case the views of E-ET educators on the use of educational technology (Kelley, 2010). A research design where there is no treatment involved is a priori research. Because this study aims to discover the views of E-ET educators on the use of educational technology at the moment in time in which they perform the Q-sort, it is exploratory and there is no treatment of the participants prior to the Q-sort process. Thus, an a priori research design is appropriate for this study.

Pilot Study

A pilot study was conducted to determine the feasibility of this dissertation. The study was conducted at a large Midwestern university during the spring 2010 semester. The purpose of the pilot study was to investigate the views of E-ET educators on the use of educational technology in engineering education. In the pilot study, views of the use of educational technology were investigated using Q Methodology. Educational technology is defined for this study as both hardware and software used by an instructor for teaching, a student for learning, or both instructor and student. Two examples of educational technology are Classroom Response Systems (clickers) and on-line course management.
systems (e.g. Springboard, WebCT, Blackboard, etc.). Clickers consist of individual handheld keypads that send a signal to a radio receiver that is connected to the instructor’s computer via a USB. Students use the handheld devices to answer multiple choice questions or other types of questions (Stowell, 2007; Fies, 2006). On-line course management systems are software packages that provide the educator the ability to post educational material on-line, engage in on-line discussions and chats, and e-mail the entire class or individual students among other similar tools (Nicholas, 2010).

Participants & Demographics of the Pilot Study

Participants for the pilot study were recruited for a large Midwestern university that includes both engineering and engineering technology programs, all of which are ABET accredited. There were 11 participants total, nine of whom returned the Q-sort which equated to an 82% response rate. Six (55%) of the participants were engineering educators and five (45%) were engineering technology educators. Nine (82%) of the participants were male and two (18%) were female. Breaking down the demographics of the pilot study by race, Six (55%) of the participants were white males, three (27%) were non-white males and two (18%) were white females. The ages of the participants ranged from 40 years to 65 years, with a mean age of 53.1 years. The time in service of the participants (years working as an engineering/engineering technology educator) ranged from 7 years to 32 years, with a mean of 19 years of service. The participants taught both undergraduate and graduate level courses in a variety of E-ET disciplines.

Development of the concourse for the Pilot Study

Concourse is the beginning of creativity and information formation in individuals and groups. Q Methodology seeks to expose the indigenous structure of a concourse. The
The concourse makes up the basis for Q Methodology to the degree it is concerned with life as it is lived, from the perspective of the person or persons involved. Once the information has been obtained from all of the interviews, conversations and other sources that are the concourse of the study, the process becomes similar to that of content analysis, which involves the systematic identification of statements that are ultimately replaced by categories that are operant or that represent functional distinctions (Brown, 1980, 1993; McKeown & Thomas, 1988). A subset of statements is then developed from the concourse (Brown, 1980, 1993; McKeown & Thomas, 1988; Ramlo, 2008). It is from the concourse that new understandings appear, new theoretical frameworks emerge and discoveries are made (Brown, 1980, 1993; McKeown & Thomas, 1988; Brown & Good, 2010). The development of a concourse can come from a variety of techniques, the most common being the interview, but commentaries, publications, Internet blogs, and casual conversations are also very common (Brown, 1980, 1993; Brown & Good, 2010). For this study the concourse was developed from interviews with E-ET educators (questions used are shown in Appendix 2), informal conversations with E-ET educators and the literature review. A subset of statements, called a Q-sample, is the set of statements which will be presented to participants in the form of a Q-sort (McKeown & Thomas, 1988; Brown, 1993). Figure 1 below shows the Q-sort grid used in the pilot study. The Q-sort process involves the participants physically sorting items, relative to each other into a normalized distribution such as the grid presented in Figure 6.

Similar to the Likert survey scale, distribution on the grid typically ranges from least like my view to most like my view. However, Q Methodology is unique in that it forces participants to rate each statement relative to the others into this forced distribution.
based upon that participant’s opinion within a particular setting, known as the condition of instruction (McKeown & Thomas, 1988). The concourse for the pilot study resulted in 48 statements. These statements are shown in Appendix 1.

Conclusions of the pilot study

The participants in this study were E-ET educators from a variety of E-ET disciplines in a mid-sized Midwestern university. The participants were asked to perform complete a demographic survey and a Q-sort developed from a concourse that included interviews conducted with E-ET educators from similar disciplines discussing the use of educational technology in their classrooms, general conversations with E-ET educators and from a review of the literature. This concourse resulted in a Q-sample of 48 statements. The analysis revealed three factors on the use of educational technology by E-ET educators.

Factor 1 or The Supplemental Group, are those who believe the traditional-lecture take note method of instructions is still the best method for teaching E-ET concepts, but at the same time see that educational technology is best used as a supplement or as a method to change-up the routine.

Factor 2 or The Traditionalists, are those who believe that the traditional lecture-take notes method is still the best method for teaching engineering/engineering technology concepts. They are reluctant to change their pedagogy to incorporate educational technology and tend to think that educational technology leads to passive learning and/or answer seeking as opposed to actual problem solving.

Factor 3, The Embracers, believe that educational technology helps them to gage their effectiveness in teaching E-ET concepts. They also believed that the 21st century
student no longer relates to the traditional lecture method of instruction and because of this seek ways to improve their pedagogy using educational technology. This study provides a beginning to understanding this reluctance in implementing the use of educational technology into engineering education courses.

Limitations of the Pilot Study

The limitations of this pilot study follow. The first limitation is that Q Methodology is not generalizable to the general population. With Q Methodology, statistical reliability or the ability to generalize sample results to the general population is of less concern because the results are the distinct subjectivities about a topic that are operant or measurable within the group of participants. Q Methodological results are not the percentage of the sample or the general population that adheres to any of the operant subjectivities (Thomas and Bass, 1992).

The second limitation of the pilot study is the Q-sample. The researcher conducted post-sort interviews with several of the participants of this pilot study. These interviews revealed that some of the statements used were unclear and other statements seemed repetitive. Those statements have been revised or removed for this study. The process used to revise the Q statements is discussed later in this chapter.

The final limitation is the number of participants. Where sampling size in Q Methodology is the number of statements and thus the number of participants is somewhat irrelevant, the goal of Q Methodology is to find the number of existing points of view on any given subjectivity. A greater number of participants may result in a greater number of factors or different factors all together.
To address these limitations, the researcher has revised the Q-sample and recruited a larger number of participants for this study.

Methods

This study used two instruments. The first instrument was a demographic and educational technology usage survey. This survey asked E-ET educators general demographic information as well as what, if any, educational technology they use in their courses and how educational technology is used if they do use it. The second will be a Q-sort similar to that used in the pilot study. The Q-sample from the pilot study has been revised based upon the knowledge gathered from the pilot study.

Demographic and Educational Technology Usage Survey

The participants completed a Demographic and Educational Technology Usage Survey (DETUS, shown in Appendix 3). This survey identified the participant’s field of expertise within the E-ET profession, time-in-service, age, gender, what, if any, educational technology is used and how it is used in the E-ET educators’ course. This information was used in conjunction with the Q-sort in order to help determine what, if any, barriers exist to the implementation of educational technology in E-ET courses. Collecting this data on an individual level eliminated the need to depend on assumptions based on any a priori knowledge about the context of what is taking place in E-ET courses of the participants that the researcher possessed prior to the sorting process (Bowe, 2010).

Q-sort

A Q-sample has been developed to elicit the views on the use of educational technology by E-ET educators. The Q sample for this study was revised based upon the
results of and the post-sort interviews of the pilot study. The revised Q-sample is shown in Appendix 4.

The statements were randomly numbered and administered to the participants in the form of a pack, which was an envelope with the statements inside. There was one statement per tab of paper (McKeown & Thomas, 1988; Brown, 1993; Ramlo, 2008; Ramlo & Nicholas, 2009).

The participants were then asked to pre-sort the items into three categories, most like my view, neutral and least like my view. Once the statements were pre-sorted into these three groups, the participants physically sorted items, relative to each other into a normalized or Gaussian distribution onto a grid (Ramlo, 2008; Ramlo & Nicholas, 2009).

![Q sort grid example](image)

Figure 6. Example of the Q sort grid used in the study

The grid for this dissertation is the same as this grid used in the pilot study as the Q-sample also consists of 48 statements.
The aforementioned steps are known as the condition of instruction (Brown 1993, 2010; Ramlo, 2008; Ramlo & Nicholas, 2009). Q is similar to the Likert-scale survey in that the distribution on the grid typically ranges from least like my view to most like my view. However, Q methodology differs from Likert-scale surveys in that Q involves participants physically sorting items relative to each other into a normalized or Gaussian distribution based upon that participant’s opinion or subjectivity within a particular setting (Ramlo, 2008; Ramlo & Nicholas, 2009; Nicholas, 2011).

*Interviews*

Q Methodology displays many of the characteristics of mixed method research techniques in that it shares many of the focuses of qualitative research while utilizing the type of statistical analyses typically found in quantitative studies (Newman & Ramlo, 2010). One of the characteristics of qualitative research involves forming questions and asking them also known as the interview process. The questions asked in interviews may be structured, semi-structured or open (Willis, J. 2007). The interview process for this study included interviews with E-ET educators from a variety of E-ET disciplines. These interviews were completed for the pilot study in the spring 2010 semester. The interview participants included those E-ET educators who are known to use educational technology and those E-ET educators who are known to not use educational technology. The questions used were open ended; designed to elicit the interviewee’s teaching style, to solicit the interviewee’s personal view on the use of educational technology in E-ET courses and to determine what, if any educational technology is being used and how it is being used. The interviews were then be transcribed and coded as part of the Q concourse process.
Data Collection

Data collection occurred during the spring 2011 semester. Data used in this dissertation is from the results of the Q-sort procedure. All participants completed the DETUS and a Q sort. The DETUS asked E-ET educators general demographic information as well as asked what, if any, educational technology they use and how they use educational technology if they do. The information gathered from the demographic and educational technology was used in conjunction with the Q sort process to determine commonalities, if any, of the participants who loaded on the same factor. The Q sort process allows the views of E-ET educators to emerge in factors (Brown, 1980, 1993; McKeown & Thomas, 1988; Ramlo, 2008).

Q sorting is a process in which participants are asked to sort statements (Q statements) developed from the concourse (more explanation of the concourse in the Instruments section). The participants sort according to how strongly they think the statements apply to them. Sorting occurs via a predetermined number of groups between the two ends of the continuum. The ends of the continuum ranged from most unlike my view (-5) to most like my view (+5). Unlike traditional surveys that require participants to answer each question independently of their other responses, Q sorting enables participants to consider the Q statements in relation to each other, creating a focalization on the participant’s individual subjectivity on the subject (Bowe, 2010).

Q-Methodology

Q Methodology is primarily an exploratory research technique that was developed by psychologist and physicist William Stephenson in the 1930’s (Watts & Stenner, 2005). Q methodology, sometimes referred to as the Q-sorting technique or simply Q, allows
researchers to identify, both quantitatively and qualitatively, the various opinions within a
group and the number of people within the group who hold these opinions (McKeown &
Thomas, 1988; Ramlo, 2008).

Q methodology strives to access the diversity of points-of-view within the group
of participants. Q Methodology provides resulting data that are agreeable to mathematical
analyses that allow the researcher to examine the subjectivity of a situation by opening
the door of possibility of connections which unaided perception may overlook (Brown,
1980, 1993; McKeown & Thomas, 1988). For this study, Q Methodology will be used to
investigate the subjectivity (views) of E-ET educators on the use of educational
technology in E-ET courses.

Q Methodology is an appropriate choice whenever a researcher wishes to explore
and determine the various perspectives and consensus within a group regarding any topic
(Brown 1980, 1993; McKeown & Thomas, 1988; Ramlo, 2008). Because the goal of this
study is to determine the various perspectives or views on the use of educational
technology in E-ET courses, Q is the appropriate methodology. The first step in Q
methodology is to develop the concourse (Brown, 1980, 1993; McKeown & Thomas,

Developing the Concourse

Concourse is the beginning of creativity and information formation in individuals
and groups. Concourse can also be described as that which is readily communicated
among groups about any given topic. It is from the concourse that new understandings
appear, new theoretical frameworks emerge and discoveries are made (Brown, 1980,
1993; McKeown & Thomas, 1988). The development of a concourse can come from a
variety of techniques, the most common being the interview, but commentaries, publications, Internet blogs, and casual conversations are also very common (Brown, 1980, 1993; McKeown & Thomas, 1988; Brown & Good, 2010). For this study, the concourse was developed from interviews with E-ET educators (questions in Appendix 2), informal conversations with E-ET educators, a review of the literature and post-sort interviews with the participants of the pilot study.

Finally, a subset of statements is then developed from the concourse. That subset of statements is called a Q sample which is the set of statements which will be presented to participants in the form of a Q sort (Brown, 1980, 1993; McKeown & Thomas, 1988; Ramlo, 2008, Newman & Ramlo, 2010).

**Developing the Q Sample**

The concourse is followed by a selection called the Q-sample that the participants will be asked to sort. Participants are asked to rank-order the statements from their point of view, according to some preference, judgment or feeling about the statements (Van Exel, 2005; Ramlo & Nicholas, 2009). These statements are developed from the concourse. Similar in a sense to the process of sampling persons in survey research, the primary goal of selecting a Q-sample is to yield statements that represent the larger process being modeled without losing the comprehensiveness (Brown, 1980, 1993; McKeown & Thomas, 1988; Ramlo, 2008, Newman & Ramlo, 2010). In this study the researcher developed the Q-sample from the concourse described above. The Q-sample for this study is shown in Appendix 4.

For this study, the following statements were removed from the Q-sample for this study. The reason for the removal is listed after the statements.
20) In general, I like all kinds of technology. This statement was used in the pilot study to determine the participants feeling of technology, but not specific to educational technology.

24) I believe using computer-based simulations helps students understand concepts. This statement was removed because it was not educational technology specific. Many of the post-sort interviewees indicated that this statement was confusing to them.

33) I believe students have a shorter attention span today than we did when I was in school. Many of the post-sort interviews indicated that the participants were confused by this statement. They indicated that they did not know where this statement fit in to the overall sort.

42) I believe students like having access to course materials online. This statement was deemed by the feedback gathered during the post sort interviews to be too similar statement 43 (I think students like to access course materials online because it is convenient and this helps them reinforce their learning).

30) I feel that educational technology allows me to provide more hands on experiences for students in the classroom. This statement was reported to be unclear to the participants.

The following statements were modified to make the statements more clear.

25) My favorite technology is a piece of graph paper. This statement was altered to read I prefer pencil and paper over educational technology. To make the statement more encompassing of the types of tools that are common in tradition lecture style E-ET classrooms.
29) I believe educational technology allows the instructor to engage students in their learning during class-time. Was modified to read I believe educational technology allows the instructor to better engage students in their learning during class-time.

46) I believe that by keeping the students engaged in the lecture with educational technology I can more easily help them to develop the critical thinking skills needed to be an effective engineer/technician/technologist. This statement was shortened to read I believe that by keeping the students engaged in the lecture with educational technology I can more easily help them to develop critical thinking skills.

Finally, the following statements were added to provide more diversity in the Q-sample.

I believe it is important to offer multiple teaching methods during class.

I believe educational technology reduces passive learning. This statement was added based on comments made by some of the participants during the post-sort interviews.

I believe that it is not worth my time outside of the classroom to learn to use educational technology.

I find educational technology more effort than it is worth to learn.

These two statements were added to help clarify the educators view on the time commitment involve with learning to use educational technology.

The Q statements that were used for this study are shown in Appendix 4. The numbers of the Q-sample have been reordered due to these changes. This reordering is of little consequence as the numbers are on the statements for sorting purposes and have no statistical significance (Brown, 1980, 1993; Brown & Good, 2010).

Conditions of Instruction
Q Methodology is similar to the Likert-scale survey in that the distribution on the grid typically ranges from least like my view to most like my view. However, Q Methodology differs from Likert-scale surveys in that Q Methodology involves participants physically sorting items relative to each other into a normalized or Gaussian distribution based upon that participant’s opinion or subjectivity within a particular setting (Ramlo & Nicholas, 2009). The participants are asked to sort the statements based on a set of instructions provided by the researcher. The aforementioned steps are known as the condition of instruction (Brown 1980, 1993; Ramlo, 2008; Ramlo & Nicholas, 2009; Brown & Good, 2010). The E-ET educators in this study were asked to sort the statement based on their view on the use of educational technology the day the sort was conducted and their views of student learning at the time the sort was conducted.

**Analysis and Interpretation**

The sorting process alone does not represent the entire process of Q Methodology. The idea that simply performing a Q-sort is the entire process of Q Methodology is a common misinterpretation of the methodology (Brown, 1980, 1993; McKeown & Thomas, 1988; Ramlo, 2008; Newman & Ramlo, 2010; Brown & Good, 2010). The Q-sort, once completed, indicates only that a set of items have been distinguished or valued differentially by the participant who performed the sort according to that individuals’ subjectivity. The Q-sort is carried out in line with the Gestalt psychology principle or how people organize elements into groups, in such a fashion that the end-point for any participant lies in the holistic configuration or patterning of all of the items in relation to each other (Watts & Stenner, 2005).
The analyses of the Q sorts involve correlation, factor analysis, factor loadings and the calculation of factor scores. Factor loadings are simply correlation coefficients that correlate the sorter with a factor or view (Brown, 1980, 1993; McKeown & Thomas, 1988; Ramlo, 2008; Newman & Ramlo, 2010; Brown & Good, 2010). The higher the factor loading, the more highly the sorter is correlated with that factor or view. Those sorters with similar views are more highly correlated with the same factor. The recommended factoring procedure, and the procedure preferred by William Stephenson himself, includes centroid extraction (data reduction) with hand rotation because this allows the researcher to investigate factors based upon theoretical considerations as well as any a priori knowledge of the subject and/or participants the researcher may possess (Newman & Ramlo, 2010).

There are several computer programs that are created specifically to handle the type of data collection and analyses in Q exist. PQ Method is one of the most common and is available for free (Ramlo, 2008; Ramlo & Nicholas, 2009). This study will use PQ method as the program of choice.

Selecting the factor extraction method is the first step of the factor analysis process. The PQ Method software (as well as some of the other software packages available) offers two options for factor extraction: Principle Components and Centroid. Principal Components analysis is frequently used in R factor analysis where there are ones in the diagonal of the matrix. The issue with using Principal Components extraction in Q Methodology is that it components analysis assumes that an individual’s sorts are invariant (correlated at 1.00). It is, however, unlikely that a person would sort items in a Q study identically, in separate sorts, even if the separation of those sorts were only a day
or two. Principle components also assumes that there is no statistical error, making centroid better in this case because there is error as evidenced by the unlikelihood that that a person would sort items in a Q study identically in separate sorts (Brown, 2009). In other words, the centroid extraction method tends to lend itself better to Q methodology because of the indeterminacy of its solution (one solution does not exist among the infinite solutions possible). Centroid extraction was the preferred method of William Stephenson for this among other reasons (Newman and Ramlo, 2010). Once the factors are extracted from the data, these factors may be rotated for further exploration. Centroid extraction and judgmental (hand rotation) will be used. This method will allow the researcher to analyze the data to use a priori knowledge about the participants and explore any hunches that may occur during the study.

Analysis of the Data

Correlation, factor analysis, factor loadings and the calculation of factor scores are all involved in the analyses of the Q-sort. Regarding factors loadings, the higher the factor loading, the more highly the sorter is correlated with that factor (Ramlo, 2008; Newman & Ramlo, 2010). Consequently, those sorters whose views are similar are highly correlated with the same factor. Thus, the factor loadings determine who loaded on which factor.

Once the factors and the individuals who loaded on them are determined, the factor scores are used to develop a representative sort for each factor. In other words, Q Methodology determines how many basically different Q sorts have emerged from the group of participants conducting the sort. Factor analysis in Q Methodology reveals how many different factors there are (Brown, 1980, 1993). Using the pilot study as an
example, the factors indicate the different views of E-ET educators’ views on the use of educational technology. Those educators who shared a common view of the use of educational technology define the same factor.

The factor loadings express the extent to which each Q-sort is associated with each factor. With little exception, only the first two or three factors contain significant loadings, although it is possible that more than three factors may emerge (Brown, 1980; 1993). However, the original set of factors is the raw materials from which the probing of these subjective relationships from vantage points of interest (Brown, 2009; McKeown & Thomas, 1988; Newman & Ramlo, 2010). Because the use of factor rotation allows the researcher to take advantage of any insights, prior knowledge, hunches, guesses and hypotheses that the researcher may have, Peirce’s theory of abduction is inherent in Q Methodology (McKeown & Thomas, 1988; Brown, 2009).

In the pilot study, EF45 loaded both factor 1 and factor 2 (0.64 and 0.54 respectively), and that ETM 59 loaded on factor 1 and factor 6 (0.58 and 0.69 respectively). This is called a ‘dirty’ loading or that the original factor scores may be slightly out of focus. To ‘clean’ the ‘dirty’ factors, or to bring the factors into focus either Varimax or hand rotation must be performed (Brown, 1980; 1993; Ramlo, 2008). In the case of the pilot study hand rotation was used because the researcher had some prior knowledge of the participants’ view that was acquired during the concourse development.

The hand rotation in the pilot study was performed on Factor1 and Factor 2, using ETM65 to move closer to Factor 2. This participant was chosen because the researcher had prior knowledge of the participant’s view on the use of educational technology and
Factor 2 was chosen because the statement rankings for Factor 2 most closely represented this participant’s view. Using hand rotation, ETM65 was ‘nudged’ closer to Factor 2.

The factors can be repositioned so as to reveal the similarities between the views of EF45 and ETM65 by rotating the factors such that one of them extends through the center of gravity between their respective Q-sorts. The factors in the graph are the axes. For the pilot study, Factor 1 was the y-axis and Factor 2 is the x-axis. Rotating the factors approximately 10-degrees clockwise resulted in was enough to ‘clean’ the factors.

The result of performing this rotation in the pilot study served not only to focus ET45 and ETM65 on factor 2, ETM59 who loaded strongly on both Factor 1 and Factor 6 has now loaded onto Factor 1 EF51 now loaded clearly on Factor 3. This rotation changes the Factor 1 and Factor 2 loadings for all the Q Sorts (Brown, 1980, 1993).

Following rotation, the researcher must select individuals who are represented by a factor. This procedure is called flagging. The PQMethod software allows for either manual or automatic flagging to be performed by the researcher (Newman & Ramlo, 2010). In the pilot study, automatic flagging was used. In Q Methodology, factor descriptions and factor analyses are determined only by those Q-sorters who are flagged on a factor (Brown, 1980; McKeown & Thomas, 1988).

Once the factor loadings have are complete, the next step in Q Methodology is to interpret the factors.

Factor Interpretation

The factor analysis of Q Methodology is conducted primarily in terms of factor scores as opposed to factor loadings, typically found in R Methodology. A factor score in Q Methodology is the score for a particular statement as a kind of an average of the
scores given to that statement by all of the Q Sorts associated with a certain factor. What is important in Q Methodology is to know what to do with the factors once they have emerged. It is equally as important to understand that measurement in Q Methodology is not concerned with units of measurement in a quantitative sense, say inches or pounds, but that Q Methodology is concerned with importance to me (Brown, 1980, 1993). The various traits of the Q Sorter become single-centered around an average degree of importance to me (the Q Sorter) and thus correlation becomes practicable (Brown, 1980; 1993). It is this importance to me that is what gives the Q Methodology researcher the insight to the sorters’ subjectivity.

The number of factors and the character of each factor are indeterminate before the Q Sort is performed. The factors that emerge from the data analysis are strictly the function of the Q Sorters themselves, making the factors grounded in more than just a conceptual sense. The factors are naturalistic as they emerge from and are inseparably tied to the concrete operations of the participants (Brown, 1980, 1993, 2008).

Comparing Q Methodology to R methodology, which typically depends on the matrix of factor loadings to reveal the connections among variables, the factor loadings in Q Methodology are of lesser interest to the researcher considering that the person sample is small and non-representative by survey standards. Instead, the interest in Q Methodology instead focuses on the array of factor scores. The factor scores reveal the subjectivity at issue, in the case of the pilot study, the view of E-ET educators on the use of educational technology. Because statements can, and frequently do, take on different meanings to different people, and also to the same people in different settings,
interpretation is becomes more intricate in Q methodology than, say, a Likert style survey where the results are more rigid (Brown & Good, 2010).

**Representative Sorts**

From these tables and factor scores, a representative sort is created from the sorts of those who are represented by a particular factor. This representative sort is one sort that represents that factor’s view (Brown, 1980; Brown, 2008; McKeown & Thomas, 1988, Newman & Ramlo, 2010).

Brown & Good (2010, p.7) describe how the factor scores are calculated “The factor scores are then calculated by multiplying each statement’s Q-sort score by the weight and then summing each statement across the weighted Q-sorts comprising the factor, with weighted statement sums then being converted into a factor array presented in the form of the original metric.” An example of a representative sort from Factor 1 in the pilot study is show in Figure 7 below.

<table>
<thead>
<tr>
<th>Least like my view</th>
<th>neutral</th>
<th>Most like my view</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5, -4, -3, -2, -1</td>
<td>0, 1, 2, 3</td>
<td>4, 5</td>
</tr>
<tr>
<td>21, 15, 2, 1, 14, 3, 9, 6, 28, 4, 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19, 11, 22, 16, 7, 10, 12, 37, 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17, 25, 18, 23, 13, 47, 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26, 36, 35, 27, 30, 24, 41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44, 39, 31, 32, 29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48, 40, 34, 33, 42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45, 38, 43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 7. An example of a representative sort from Factor 1 of the pilot study.
Distinguishing Statements

To obtain quick access into what is distinctive about the three perspectives can be obtained by examining statements which distinguish them (Brown, 1993). Distinguishing factor statements and consensus statements are also identified via the PQMethod analysis and reported in the printout (Brown, 1980; McKeown & Thomas, 1988). Tables of the distinguishing statements are shown in the pilot study section above. In order to determine the distinguishing statements a difference score is calculated. Van Exel (2005, p9) describes difference scores as follows: “The difference score is the magnitude of difference between a statement’s score on any two factors that is required for it to be statistically significant. When a statement’s score on two factors exceeds this difference score, it is called a distinguishing (or distinctive) statement.” When a statement is not distinguishing between any of the factors it becomes a consensus statement (McKeown & Thomas, 1988; van Exel, 2005; Brown, 2009; Newman & Ramlo, 2010).

Consensus statements

Consensus statements do not distinguish between any of the factors (Brown, 1980, 1993). Consensus statements allow the researcher to focus on agreement among factors which can be used to find commonality among the participants (Ramlo, 2005). In other words, the factors and distinguishing statements show the difference within the participants’ points of view; the consensus items point where agreement exists and cooperation is possible (Brown, 1980, 1993). In addition to the tables of distinguishing statements for each factor, a table of consensus statements for the factors is provided in the Q methodology analyses’ report (Newman & Ramlo, 2010). In the pilot study, there was consensus among the three factors on the E-ET educators’ views on the use of
educational technology. The consensus yielded additional information related to E-ET educators’ epistemologies. In the pilot study, twenty-one consensus statements emerged from the factor analysis. Of these twenty-one statements, four of them stood out to the research as very telling. Statement 4 (I believe a good lecturer can teach concepts without educational technology) scored positively for all 3 factors. This indicates that even the educational technology embracers believe that a good lecturer can affect students’ learning without technology. Statement 8 (I like to listen to students to determine if they are grasping a concept) also scored positively on all three factors. This indicates that regardless of using technology or not, all of these educators listen to student feedback to gage the learning of concepts. Statement 15 (I believe that there is no good way to use technology to augment teaching engineering concepts) scored negatively on all three factors. This indicates, that despite the educators personal view on the use of educational technology, they all saw some potential for educational technology in the E-ET classroom. Finally, Statement 24 (I believe using computer-based simulations helps students understand concepts) all scored positively on all three factors, indicating that all of the educators believe that making use of computer simulations aids in the learning of engineering concepts.

Thus, the consensus statements in this study show where E-ET educators’ views on the use of educational technology converge. This offers opportunities to open dialogue on how to implement educational technology in E-ET classroom technology and, in particular, implementing the TPACK framework.

Validity in Q Methodology
Q methodology measures subjectivity, or the respondents’ personal point of view or preferences. Because there is no right or wrong of a sorter’s preference(s), validity does not matter with Q. In other words, because there is no external criterion for an individuals’ point of view, the issue of validity of Q Sorts does not apply (Brown, 1980, 1993, 2009; McKeown & Thomas, 1988). The sample statements are usually reviewed by field experts and the sample statements are often tested in pilot studies. This is done to ensure content validity. In this study the statements were tested in a pilot study.

Regarding concerns about comprehensiveness and representativeness of any given sample in Q Methodology, instrument design is performed carefully in much the same way as participant selection is conducted for survey studies (Valenta & Wigger 1997).

Reliability in Q Methodology

The most important type of reliability for Q Methodology is replicability. In other words, will the same condition of instruction lead to factors that represent similar viewpoints on the topic across similarly structured, yet different Q-samples, when administered to different sets of persons (Van Exel, 2005)? Test-retest reliability of Q Sorts has been demonstrated to range from 0.80 upward (Brown 1980, 1993, Thomas and Bass, 1992, Nicholas, 2011). One important notion behind Q Methodology is that only a limited number of distinct viewpoints exist on any subject. A well-structured Q-sample, which should include a wide range of existing opinions on the subject, will reveal these distinct viewpoints (Brown, 1980, 1993). With Q Methodology, statistical reliability or the ability to generalize sample results to the general population is of less concern. With Q Methodological study, the results are the distinct subjectivities about a topic that are
operant or measurable within the group of the participants who performed the Q-sort (Thomas and Bass, 1992).

Limitations

A limitation of this study is that Q Methodology is not generalizable to the general population. With Q Methodology, statistical reliability or the ability to generalize sample results to the general population is of less concern. In a Q methodological study, the results are the distinct subjectivities about a topic that are operant or measurable. Q methodological results are not the percentage of the sample or the general population that adheres to any of the operant subjectivities (Thomas and Bass, 1992).

Summary

The general and specific research hypotheses were derived by both logical and empirical findings. Q Methodology was chosen as the research method because it examines the subjectivity or views of the participants. An earlier pilot study was conducted to determine the feasibility of the study. The results of the pilot study resulted in three factors of the views of E-ET educators’ views on the use of educational technology in E-ET courses.
CHAPTER IV
RESULTS OF THE STUDY

The purpose of this study was to identify the subjectivity or views that engineering/technology (E-ET) educators possess about the use of educational technology in the E-ET courses. This chapter begins with a description of the participants. The remainder of the chapter focuses on the results of the data analysis and testing the specific research hypotheses.

Demographic Data for the Study

Participants for the pilot study were recruited from a large Midwestern university that includes both engineering and engineering technology programs, all of which are ABET accredited. ABET, Incorporated is responsible for the specialized accreditation of educational programs in applied science, computing, engineering, and technology (ABET, 2010). Engineering education is defined as the activity of teaching engineering at college or university level preparing the graduate for a profession as a practicing engineer. Engineering Technology education defined as the activity of teaching the applied aspects of science and engineering preparing graduates for practice in that portion of the technological spectrum closest to product improvement, industrial processes, and operational functions (ABET, 2010). Where there are some differences in the focus between engineering and engineering technology, the concepts taught in E-ET are the same in the respective disciplines. The difference in the two disciplines lies primarily in
the level of math used (higher mathematics are necessary for engineering) and more application (more hands-on laboratory time in ET). E-ET educators are those who teach E-ET at the undergraduate or graduate level.

The participants were from the following disciplines: Electrical Engineering, Electronic Engineering Technology, Civil Engineering, Construction Engineering Technology, Surveying Engineering Technology, Mechanical Engineering Technology, and Automated Manufacturing Engineering Technology. There were 19 participants total, 14 who returned the Q-sort which equated to a 74% response rate.

Of the 14 who returned the survey and Q-sort, four (29%) of the participants were engineering educators and ten (71%) were engineering technology educators. Twelve (86%) of the participants were male and two (14%) were female. Breaking down the demographics of the study by race, ten (64%) of the participants were white males, two (21%) were non-white males and two (14%) were white females. Based upon the demographic information available from the Nelson (2007) study, the participants from the pilot study reflect the demographics of the E-ET education field. The ages of the participants ranged from 37 years to 66 years, with a mean age of 53.7 years. The time in service of the participants (years working as an engineering/engineering technology educator) ranged from 2 years to 33 years, with a mean of 17 years of service. The participants taught both undergraduate and graduate level courses in the aforementioned E-ET disciplines.

Some of the participants from the pilot study were also recruited for this study. The Demographic and Educational Usage Survey (DETUS) was expanded from the pilot study and some of the Q- statements were changed based on the result and post-sort
interviews of the pilot study. The participant selection was conducted to insure that the participants are representative of a variety of E-ET disciplines, gender, age, and use/non-use of educational technology.

Data Collection

Data collection occurred during the spring 2011 semester. Data used in this dissertation is from the responses on the DETUS and from the results of the Q-sort procedure. All participants completed a DETUS and a Q-sort. The DETUS asked E-ET educators general demographic information as well as asked what, if any, educational technology they use and how they use educational technology if they do. The DETUS is shown in Appendix 3. The information gathered from the DETUS was used in conjunction with the Q-sort process to determine commonalities, if any, of the participants who loaded on the same factor as well as to gain a richer understanding of the E-ET educators’ pedagogy as well as the factors that emerged from the Q-sort process. The Q-sort process allows the views of E-ET educators to emerge in factors (Brown, 1980, 1993; McKeown & Thomas, 1988; Ramlo, 2008). Along with a richer understanding of the E-ET educators’ epistemology, using the survey and Q-sort process together allowed the research insight as to why these E-ET educators used educational technology, if they did, and how it relates to their personal pedagogy.

Q-sorting is a process in which participants are asked to sort statements (Q Statements) developed from the concourse (more explanation of the concourse in the Instruments section). The participants sort according to how strongly they think the statements apply to them. Sorting occurs via a predetermined number of groups between the two ends of the continuum. The ends of the continuum ranged from most unlike my
view (-5) to most like my view (+5). Unlike traditional surveys that require participants
to answer each question independently of their other responses, Q-sorting enables
participants to consider the Q statements in relation to each other, creating a focalization
on the participant’s individual subjectivity on the subject (Bowe, 2010). The sorting grid
used in this study is shown in Figure 8 below.

![Q-sort grid used in this study.](image)

**Figure 8.** Q-sort grid used in this study.

**Analysis of the Data**

Correlation, factor analysis, factor loadings and the calculation of factor scores
are all involved in the analyses of the Q-sort. Regarding factors loadings, the higher the
factor loading, the more highly the sorter is correlated with that factor (Ramlo, 2008;
Newman & Ramlo, 2010). Consequently, those sorters whose views are similar are
highly correlated with the same factor. Thus, the factor loadings determine who loaded on which factor.

Once the factors and the individuals who loaded on them are determined, the factor scores are used to develop a representative sort for each factor. In other words, Q Methodology determines how many basically different Q-sorts have emerged from the group of participants conducting the sort. Factor analysis in Q Methodology reveals how many different factors there are (Brown, 1980, 1993). Using the pilot study as an example, the factors indicate the different views of E-ET educators’ views on the use of educational technology. Those educators who shared a common view of the use of educational technology define the same factor.

The factor loadings express the extent to which each Q-sort is associated with each factor. With little exception, only the first two or three factors contain significant loadings, although it is possible that more than three factors may emerge (Brown, 1980; 1993). However, the original set of factors is the raw materials from which the probing of these subjective relationships from vantage points of interest (Brown, 2009; McKeown & Thomas, 1988; Newman & Ramlo, 2010). Because the use of factor rotation allows the researcher to take advantage of any insights, prior knowledge, hunches, guesses and hypotheses that the researcher may have, Peirce’s theory of abduction is inherent in Q Methodology (McKeown & Thomas, 1988; Brown, 2009).

*Analysis and Interpretation*

The descriptions and analysis of the factor descriptions are determined only by those Q-sorters who are flagged on that factor (Brown, 2009; McKeown & Thomas,
It is necessary to flag sorters before the analyses produce a report that involves a variety of tables (Newman & Ramlo, 2010). These tables are developed statistically and they help the researcher’s description of the views developed from the factor scores. The three factor matrix shown in Table 2 is the result of centroid factor analysis and Varimax rotation. The combination of centroid and Varimax was chosen because it produced a clearer and more detailed description of the data as three distinct factors emerged from this combination of data analysis techniques. Table 2 shows those factors on which a participant was flagged. An ‘X’ next to the code for that participant indicates loading on that factor.

Table 2
Factor Matrix with an X Indicating a Defining Sort.

<table>
<thead>
<tr>
<th>QSORT</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ETM45</td>
<td>0.2928</td>
<td>0.3220</td>
<td>0.5797X</td>
</tr>
<tr>
<td>2 ETF46</td>
<td>0.5219X</td>
<td>0.1075</td>
<td>0.2227</td>
</tr>
<tr>
<td>3 ETM57</td>
<td>0.6614X</td>
<td>0.1530</td>
<td>0.4488</td>
</tr>
<tr>
<td>4 EF44</td>
<td>0.0098</td>
<td>0.3131</td>
<td>0.6009X</td>
</tr>
<tr>
<td>5 ETM60*</td>
<td>0.2954</td>
<td>0.3998X</td>
<td>0.3676</td>
</tr>
<tr>
<td>6 ETM50</td>
<td>0.7616X</td>
<td>0.1353</td>
<td>0.1192</td>
</tr>
<tr>
<td>7 ETM64*</td>
<td>0.5471</td>
<td>0.3369</td>
<td>0.5751X</td>
</tr>
<tr>
<td>8 EM37</td>
<td>0.1273</td>
<td>0.5870X</td>
<td>0.1694</td>
</tr>
</tbody>
</table>
9 ETM66 0.076 0.7113X 0.1002
10 ETM65 0.7558X 0.2031 0.1121
11 EM52 0.7434X 0.0258 0.1580
12 ETM48 0.3915 0.2195 0.5008X
13 EM53 0.5454X 0.017 0.1748
14 ETM65A 0.1977 -0.1296 0.5621X

% expl. Var. 24 11 15

*The researcher flagged these participants on the factor based upon responses to survey and post-sort interview questions.

Two of the tables that are developed for analysis in Q Methodology are consensus and distinguishing factor statements, which allow the researcher to explore what is common among and different between the factors (Brown, 1980, 1993, 2009; McKeown & Thomas, 1988, Newman & Ramlo, 2010). In order to determine the distinguishing statements a difference score is calculated. Van Exel (2005, p.9) describes difference scores as follows: “The difference score is the magnitude of difference between a statement’s score on any two factors that is required for it to be statistically significant. When a statement’s score on two factors exceeds this difference score, it is called a distinguishing statement.” When a statement is not distinguishing between any of the factors it becomes a consensus statement (van Exel, 2005). Consensus statements are those statements that are common among the factors. Table 2 below shows the factor scores or where those statements would appear in the ideal sort each factor, with the distinguishing statements for each factor in bold and the consensus statements italicized.
Table 3
Factor Values for Each Statement from the study with the distinguishing statements for each factor in bold and consensus statements italicized.

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Factor Arrays</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I don’t think I need educational technology to make my teaching more effective.</td>
<td>-1 0 0</td>
</tr>
<tr>
<td>2</td>
<td>I believe the use of educational technology hampers students’ critical thinking.</td>
<td>-2 -3 0</td>
</tr>
<tr>
<td>3</td>
<td>I believe using educational technology encourages students to look only for answers and ignore the problem solving process.</td>
<td>-1 2 2</td>
</tr>
<tr>
<td>4</td>
<td>I believe a good lecturer can teach concepts without educational technology.</td>
<td>1 1 4</td>
</tr>
<tr>
<td>5</td>
<td>I believe that students best learn concepts through repetition and practice.</td>
<td>2 -3 5</td>
</tr>
<tr>
<td>6</td>
<td>I feel that by encouraging open feedback and discussion in a classroom setting students will openly respond.</td>
<td>0 3 1</td>
</tr>
<tr>
<td>7</td>
<td>I believe when educational technology is used it encourages students to respond to questions.</td>
<td>3 -2 -1</td>
</tr>
<tr>
<td>8</td>
<td>I like to try new ideas to improve my teaching.</td>
<td>2 0 4</td>
</tr>
<tr>
<td>9</td>
<td>I think most students enjoy using educational technology.</td>
<td>1 2 0</td>
</tr>
<tr>
<td>10</td>
<td>I think educational technology can be used to reinforce the learning of concepts to supplement lab activities.</td>
<td>3 1 0</td>
</tr>
<tr>
<td>11</td>
<td>I think the learning of concepts can only take place in the laboratory.</td>
<td>-4 -3 -2</td>
</tr>
<tr>
<td></td>
<td>Statement</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>12</td>
<td>I believe using educational technology helps students to remain engaged in the lecture when they would not be otherwise.</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>I feel that students who ‘tune out’ in class will do so whether or not educational technology is used.</td>
<td>-1</td>
</tr>
<tr>
<td>14</td>
<td>I believe that I am focused on improving student's learning in my courses.</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>I believe that there is no good way to use educational technology to augment teaching.</td>
<td>-2</td>
</tr>
<tr>
<td>16</td>
<td>I feel that educational technology only teaches students to use shortcuts.</td>
<td>-2</td>
</tr>
<tr>
<td>17</td>
<td>I think that students do not learn the fundamentals needed to be a good engineer when educational technology is used.</td>
<td>-3</td>
</tr>
<tr>
<td>18</td>
<td>I think the use of educational technology teaches students to depend on gadgets.</td>
<td>-2</td>
</tr>
<tr>
<td>19</td>
<td>I do not like to use educational technology.</td>
<td>-4</td>
</tr>
<tr>
<td>20</td>
<td>I feel education-based technology has no place in the engineering / engineering technology classroom.</td>
<td>-5</td>
</tr>
<tr>
<td>21</td>
<td>I feel my teaching style has been effective for years and I see no reason to change my method if it is working.</td>
<td>-1</td>
</tr>
<tr>
<td>22</td>
<td>I like the traditional lecture method of teaching best.</td>
<td>-3</td>
</tr>
<tr>
<td>23</td>
<td>I believe that it is not worth my time outside of the classroom to learn to use educational technology.</td>
<td>-1</td>
</tr>
<tr>
<td>24</td>
<td>I find educational technology more effort than it is worth to learn.</td>
<td>-2</td>
</tr>
<tr>
<td>25</td>
<td>I like to listen to students to determine if they are grasping a concept.</td>
<td>5</td>
</tr>
<tr>
<td>26</td>
<td>I believe it is important to offer multiple teaching methods during class.</td>
<td>4</td>
</tr>
<tr>
<td>27</td>
<td>I feel students will not be prepared for the FE/PE exam if educational technology is used.</td>
<td>-2</td>
</tr>
<tr>
<td></td>
<td>Statement</td>
<td>Score</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>28</td>
<td>I believe that today’s students learn differently than students did 25 years ago.</td>
<td>0</td>
</tr>
<tr>
<td>29</td>
<td>I believe it is important to engage current students in doing a task related to the concept.</td>
<td>2</td>
</tr>
<tr>
<td>30</td>
<td>I believe educational technology allows the instructor to better engage students in their learning.</td>
<td>1</td>
</tr>
<tr>
<td>31</td>
<td>I think the immediate feedback that educational technology provides allows instructors to quickly gauge the effectiveness of their teaching.</td>
<td>3</td>
</tr>
<tr>
<td>32</td>
<td>I believe the immediate feedback that educational technology provides allows the student to quickly gauge their level of understanding.</td>
<td>3</td>
</tr>
<tr>
<td>33</td>
<td>I believe today’s students do not relate to an instructor talking for 50 minutes or longer.</td>
<td>0</td>
</tr>
<tr>
<td>34</td>
<td>I think that the traditional style of lecturing is not an effective way to teach today's students.</td>
<td>0</td>
</tr>
<tr>
<td>35</td>
<td>I believe using educational technology is necessary for students to be engaged in the learning process.</td>
<td>0</td>
</tr>
<tr>
<td>36</td>
<td>I think students need to be exposed to a wide variety of technologies in the classroom and laboratory.</td>
<td>0</td>
</tr>
<tr>
<td>37</td>
<td>I believe students have to take notes to learn.</td>
<td>-1</td>
</tr>
<tr>
<td>38</td>
<td>I don’t feel educational technology aid students’ learning.</td>
<td>-3</td>
</tr>
<tr>
<td>39</td>
<td>I like to use technology in my day to day life (home).</td>
<td>1</td>
</tr>
<tr>
<td>40</td>
<td>I prefer to use educational technology as a supplement to the lecture.</td>
<td>0</td>
</tr>
<tr>
<td>41</td>
<td>I think students like to access course materials online because it is convenient and this helps them reinforce their learning.</td>
<td>1</td>
</tr>
<tr>
<td>42</td>
<td>I think that using educational technology reduces the amount of student’s texting and daydreaming while in my class.</td>
<td>0</td>
</tr>
<tr>
<td>43</td>
<td>I think of educational technology as a way to</td>
<td>1</td>
</tr>
</tbody>
</table>
minimize ‘human photocopying’ meaning students are merely copying what I am writing on the board / Power Point / overhead.

44 I think my college/institution supports the use of educational technology. 2 2 0
45 I believe that by keeping the students engaged in the lecture with educational technology I can more easily help them to develop critical thinking skills. 1 1 0
46 I believe that students prefer the traditional lecture and take notes method of instruction. -1 1 1
47 I prefer pencil and paper over educational technology. -3 -1 1
48 I like to use technology for my engineering/engineering technology work. 2 1 2

A table of the distinguishing statements for each factor will be shown in the analysis for that factor later in the chapter.

Generally, the statements ranked at the extreme ends of a composite sort are called the characterizing statements. In other words, the statements that ranked as most like my view and least like my view are used to provide a starting point to describe the view represented by that factor. These statements show the researcher the extremes of this factor or view. The consensus and distinguishing statements are used to illuminate the similarities and differences between the factors respectively. To further understand an individual participant’s sort, it is generally advisable to conduct a post-sort interview to have the participant explain to the researcher why the sort was arranged the way it was. This can allow the researcher to gain confirmation of the analysis and/or further insight into the factor’s meaning (McKeown & Thomas, 1988; van Exel, 2005; Brown, 2009). For this study, the research asked post-sort questions on the sorting grid sheet and
allowed the participant to self-report about the decision making process used during the sorting process. The asked questions were:

1. Why is your view most like the statement you placed under +5 (most like my view)?
2. Why is your view least like the statement you placed under +5 (least like my view)?
3. Make any comments about your decision-making process:

The responses to these questions allowed the researcher to further identify the commonalities among those sorters who loaded on the same factor as well as to help define the factor itself.

*Factor Analysis of the Q-sort*

In this study, the researcher asked the E-ET educators to sort 48 statements based upon their views about the use of educational technology in E-ET courses. The analysis resulted in three views or factors. Of the fourteen respondents, six were represented on Factor 1 or what the researcher has named "Student Engagers". These educators are those who feel that it is important to engage the students in the learning process and view educational technology as a valuable tool in doing so. Table 4 and Table 5 contain the top 6 most-like and least-like statements for this factor, respectively.

The two statements that help to define this factor are statement 32 (I believe the immediate feedback that educational technology provides allows the student to quickly gauge their level of understanding) and 31 (I think the immediate feedback that educational technology provides allows instructors to quickly gauge the effectiveness of their teaching). These statements indicate that these educators tend to think that being able to immediately gauge conceptual understanding is important for both the instructor and the student. This supposition is further supported by the written comment from
participant ETM57 in response to post-sort questions 1 (Why is your view most like the statement you placed under +5 (most like my view)?)：“An instructor Needs Feedback from the student to ensure the student is grasping the concept.” ETM57’s +5 (most like my view) statement was statement 25 (I like to listen to students to determine if they are grasping a concept). ETM57 stated that clickers were used in the classroom as one method of acquiring this feedback. This instructor also indicated that clickers were used in during the lecture to both increase participation and as the chosen method to “listen” to the students to determine if they are grasping a concept. Participant EM52 further supported this idea by stating the reason he used educational technology in the classroom was to “Increase Active Learning, Objective Progress Assessment”. All of the participants who loaded on Factor 1 indicated in some fashion that increased student participation and the ability to immediately gauge conceptual comprehension were the main reasons that they made use of educational technology in their courses. See Table 13 below for the statements for each participant.

The “Student Engagers” group also shared a favorable view of using educational technology as indicated by the following statements appearing in the six least like my view table (Table 5). Statement 20 (I feel education-based technology has no place in the engineering/engineering technology classroom) on grid position -5 and statement 19 (I do not like to use educational technology) on grid position -4.

Finally, the distinguishing statements of Factor 1 (Table 6) or the “Student Engagers” indicate that these E-ET educators tend to be student-centered educators as indicated by statement 32 (I believe the immediate feedback that educational technology provides allows the student to quickly gauge their level of understanding), statement 31 (I
think the immediate feedback that educational technology provides allows instructors to quickly gauge the effectiveness of their teaching), statement 7(I believe when educational technology is used it encourages students to respond to questions) and statement 12(I believe using educational technology helps students to remain engaged in the lecture when they would not be otherwise) appearing in the distinguishing statements table (Table 6). The common theme among these participants is that student participation and feedback are important to these educators. This is supported by EM52’s statement on why educational technology is used in the classroom: “Clickers-used for collaborative learning, peer to peer instruction, and checking if student grasp of concepts”.

Table 4

Six Most-Like My View Statements for Factor 1 "Student Engagers".

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Grid Pos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>I like to listen to students to determine if they are grasping a concept.</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>I believe that I am focused on improving student's learning in my courses.</td>
<td>4</td>
</tr>
<tr>
<td>26</td>
<td>I believe it is important to offer multiple teaching methods during class.</td>
<td>4</td>
</tr>
<tr>
<td>32</td>
<td>I believe the immediate feedback that educational technology provides allows the student to quickly gauge their level of understanding.</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>I think educational technology can be used to reinforce the learning of concepts to supplement lab activities.</td>
<td>3</td>
</tr>
<tr>
<td>31</td>
<td>I think the immediate feedback that educational technology provides allows instructors to quickly gauge the effectiveness of their teaching.</td>
<td>3</td>
</tr>
</tbody>
</table>
Table 5

Six Least-Like My View Statements for Factor 1 "Student Engagers".

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Grid Pos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>I like the traditional lecture method of teaching best.</td>
<td>-3</td>
</tr>
<tr>
<td>47</td>
<td>I prefer pencil and paper over educational technology.</td>
<td>-3</td>
</tr>
<tr>
<td>38</td>
<td>I don’t feel educational technology aid students’ learning.</td>
<td>-3</td>
</tr>
<tr>
<td>11</td>
<td>I think the learning of concepts can only take place in the laboratory.</td>
<td>-4</td>
</tr>
<tr>
<td>19</td>
<td>I do not like to use educational technology.</td>
<td>-4</td>
</tr>
<tr>
<td>20</td>
<td>I feel education-based technology has no place in the engineering / engineering technology classroom.</td>
<td>-5</td>
</tr>
</tbody>
</table>

Table 6

Distinguishing Statements for Factor 1 "Student Engagers".

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 2 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rank   Rank Rank</td>
</tr>
<tr>
<td>32</td>
<td>I believe the immediate feedback that educational technology provides allows the student to quickly gauge their level of understanding.</td>
<td>3 -2 -1</td>
</tr>
<tr>
<td>10</td>
<td>I think educational technology can be used to reinforce the learning of concepts to supplement lab activities.</td>
<td>3 1 0</td>
</tr>
</tbody>
</table>
Three of the fourteen respondents were represented by Factor 2. The researcher named this factor “The Entertainers”. Table 7 and Table 8 contain the six most-like and least-like statements for this factor, respectively. Table 9 contains the distinguishing statements for this factor. These E-ET educators view educational technology as gadgets or gizmos as indicated by statement 18 (I think the use of educational technology teaches
students to depend on gadgets) appearing on grid position 3 in the six most like my view statements (Table 7).

“The Entertainers” are not necessarily anti-educational technology. Statement 15 (I believe that there is no good way to use educational technology to augment teaching) appears at grid position -4 in the six least-like my view statements (Table 8) and in fact all of these participants reported using educational technology in their courses. “The Entertainers” are not opposed to changing or adapting their approach to teaching as indicated by statement 21 (I feel my teaching style has been effective for years and I see no reason to change my method if it is working) appearing at grid position -5 in the six least like my view table (Table 8). This indicates that the issue is not with the use of educational technology itself nor is the issue as refusal to improve their pedagogy.

The participants who loaded on Factor 2 tended to be teacher-centered in their approach to teaching. This is supported by the both the distinguishing statements (Table 8) and the most like my view statements (Table 7) for this factor. It is further supported by the answers to the survey questions of how these participants used educational technology in the classroom. ETM66 reported that during class this participant uses overheads with handouts and demonstrations of the actual technology being taught. However, ETM66 made no mention of what the students are doing while the demonstration is occurring nor was anything mentioned about including the students in the demonstration, indicating a very passive learning pedagogy. EM37 reported that during class EM37 uses a tablet PC with Power Points, demonstrates of various scenarios with software, and Internet to find resources. EM37 stated “You have to engage the students on multiple levels, especially the lower classmen. You have to engage to the
point of being entertaining.” The results of the Q-sort combined with this participant’s comments indicate that EM37’s view of engagement is being entertaining for the students to keep them paying attention during the lecture. Again, no mention of what the students are doing during while the entertaining is occurring. ETM60 responded to the port-sort question “Why is your view most like the statement placed under +5 (most like my view)?” by stating: “For weaker students it’s our challenge to inform motivate and keep on task. Otherwise, the students will tune out often.” All of these participants made use of what they defined as educational technology, but used it in a very traditional teacher-centered style. Further supporting the teacher-centered supposition is that there was no mention in their self-reporting about what the students were doing during the lecture.

These educators’ views on student attitudes are evidenced by statement 13 (I feel that students who ‘tune out’ in class will do so whether or not educational technology is used) appearing in both the six most like my view table (Table 7) and in the distinguishing statements table (Table 9). This indicates that “The Entertainers” believe that if they are animated enough and have adequate demonstrations, they can keep the attention of the “daydreamers” and “weaker” students regardless of whether or not educational technology is involved. In other words, entertainment leads to student engagement and that is solely the responsibility of the instructor.

Table 7

Six Most-Like My View Statements for Factor 2 "The Entertainers"

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Grid Pos.</th>
</tr>
</thead>
</table>

92
I like to listen to students to determine if they are grasping a concept.

I feel that students who ‘tune out’ in class will do so whether or not educational technology is used.

I believe it is important to offer multiple teaching methods during class.

I feel that by encouraging open feedback and discussion in a classroom setting students will openly respond.

I believe it is important to engage current students in doing a task related to the concept.

I think the use of educational technology teaches students to depend on gadgets.

Table 8

Six Least-Like My View Statements for Factor 2 "The Entertainers"

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Grid Pos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>I believe that students best learn concepts through repetition and practice.</td>
<td>-3</td>
</tr>
<tr>
<td>11</td>
<td>I think the learning of concepts can only take place in the laboratory.</td>
<td>-3</td>
</tr>
<tr>
<td>15</td>
<td>I believe that there is no good way to use educational technology to augment teaching.</td>
<td>-4</td>
</tr>
<tr>
<td>35</td>
<td>I believe using educational technology is necessary for students to be engaged in the learning process.</td>
<td>-4</td>
</tr>
<tr>
<td>42</td>
<td>I think that using educational technology reduces the amount of student’s texting and daydreaming while in my class.</td>
<td>-4</td>
</tr>
<tr>
<td>21</td>
<td>I feel my teaching style has been effective for years and I see no reason to change my method if it is working.</td>
<td>-5</td>
</tr>
</tbody>
</table>

Table 9

Distinguishing statements for Factor 2 "The Entertainers"
<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Rank</th>
<th>Score</th>
<th>Rank</th>
<th>Score</th>
<th>Rank</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>I feel that students who ‘tune out’ in class will do so whether or not educational technology is used.</td>
<td>-1</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>I believe that it is not worth my time outside of the classroom to learn to use educational technology.</td>
<td>-1</td>
<td>2</td>
<td>-4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>I feel that educational technology only teaches students to use shortcuts.</td>
<td>-2</td>
<td>1</td>
<td>-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>I think that students do not learn the fundamentals needed to be a good engineer when educational technology is used.</td>
<td>-3</td>
<td>1</td>
<td>-3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>I find educational technology more effort than it is worth to learn.</td>
<td>-2</td>
<td>0</td>
<td>-3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>I feel students will not be prepared for the FE/PE exam if educational technology is used.</td>
<td>-2</td>
<td>0</td>
<td>-3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>I prefer pencil and paper over educational technology.</td>
<td>-3</td>
<td>-1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>I do not like to use educational technology.</td>
<td>-4</td>
<td>-1</td>
<td>-5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>I believe educational technology allows the instructor to better engage students in their learning.</td>
<td>1</td>
<td>-2</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I believe that students best learn concepts through repetition and practice.</td>
<td>2</td>
<td>-3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>I believe using educational technology is necessary for students to be engaged in the learning process.</td>
<td>0</td>
<td>-4</td>
<td>-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>I think that using educational technology reduces the amount of student’s texting and daydreaming while in my class.</td>
<td>0</td>
<td>-4</td>
<td>-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>I feel my teaching style has been effective for years and I see no reason to change my method if it is working.</td>
<td>-1</td>
<td>-5</td>
<td>-1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Five of the fourteen respondents are represented on Factor 3, or "This is how I learned". Table 11 and Table 12 contain the top 6 most-like my view and least-like my
view statements for this factor, respectively. Table 12 shows the distinguishing statements for this factor.

These educators tend to see some value in using educational technology, however, they had a very traditional teacher-centered view about how students learned. This is supported by statement 5 (I believe that students best learn concepts through repetition and practice), statement 4 (I believe a good lecturer can teach concepts without educational technology) statement 37 (I believe students have to take notes to learn) and statement 40 (I prefer to use educational technology as a supplement to the lecture) appearing in the six most like my view table (Table 10). All of these statements represent a traditional teacher-centered epistemology.

Three of these participants viewed using any kind of technology as educational technology. In other words, because they taught students ‘how’ to use technology, they viewed the Q statements as relating to industry standard technology or the technology tools used in their respective fields. ETM65A’s primary concern is that graduates of this particular program are able to use the tools they will use on the job. In all of ETM65A’s responses, there was neither mention of conceptual understanding of the material being presented nor any mention of student engagement in the classroom. ETM64, ETM48 and ETM45 all provided very similar responses to the survey questions. All four of these participants used Power Point and industry standard technology in their classrooms primarily in a teacher-centered, demonstrative fashion. Further, during a post-sort personal conversation with ETM65A, this participant stated that there are tried and true methods that are known to work. ETM65A used technology as a supplement to those tried and true methods, but has not adopted a more student-centered approach to teaching.
EF 44 was the only participant who did not use educational technology. Further defining this factor as “This is how I learned” is statement 47 (I prefer pencil and paper over educational technology) and statement 2 (I believe the use of educational technology hampers students’ critical thinking) appearing in the distinguishing statements.

EF44 stated the reason for placing statement 5 (I believe that students best learn concepts through repetition and practice) in the +5 (most like my view) position on the sorting grids as “Regardless of the activity (learning an engineering concept, musical instrument, language, sport, etc.) best way to obtain expertise is through practice.” ETM64 also ranked statement 5 at +5 on the grid. ETM64 stated “I am very Deweyan (referring to John Dewey). We learn by doing. We perfect by practicing. If I can get a student to willingly practice, positive results are almost guaranteed.” This reason is very similar to EF44’s reason for placing the statement in the +5 (most like my view) grid position in that they both support the traditional teacher-centered idea that repetition and practice is the best way to learn. Similar to Factor 2, none of the participants who loaded on Factor 3 made any mention of what the students were doing during the lecture nor was there any mention of how the students were engaged with the educational technology being used in the class, if educational technology was used at all. These educators seem to share the philosophy that it is their role to present the material and that conceptual understanding, which is the responsibility of the student, is best achieved through repetition and practice. The use or non-use of educational technology was not tied to student conceptual understanding by those E-ET educators who loaded on this factor.

Table 10

Six Most-Like My View Statements for Factor 3 "This is how I
learned".

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Grid Pos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>I believe that students best learn concepts through repetition and practice.</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>I believe a good lecturer can teach concepts without educational technology.</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>I like to try new ideas to improve my teaching.</td>
<td>4</td>
</tr>
<tr>
<td>37</td>
<td>I believe students have to take notes to learn.</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>I believe that I am focused on improving student's learning in my courses.</td>
<td>3</td>
</tr>
<tr>
<td>40</td>
<td>I prefer to use educational technology as a supplement to the lecture.</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 11

Six Least-Like My View Statements for Factor 3 "This is how I learned".

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Grid Pos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>I think that students do not learn the fundamentals needed to be a good engineer when educational technology is used.</td>
<td>-3</td>
</tr>
<tr>
<td>24</td>
<td>I find educational technology more effort than it is worth to learn.</td>
<td>-3</td>
</tr>
<tr>
<td>27</td>
<td>I feel students will not be prepared for the FE/PE exam if educational technology is used.</td>
<td>-3</td>
</tr>
<tr>
<td>15</td>
<td>I believe that there is no good way to use educational technology to augment teaching.</td>
<td>-4</td>
</tr>
<tr>
<td>23</td>
<td>I believe that it is not worth my time outside of the classroom to learn to use educational technology.</td>
<td>-4</td>
</tr>
<tr>
<td>19</td>
<td>I do not like to use educational technology.</td>
<td>-5</td>
</tr>
</tbody>
</table>
Table 12

Distinguishing Statements for Factor 3 "This is how I learned".

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Rank</th>
<th>Rank</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>I believe that students best learn concepts through repetition and practice.</td>
<td>2</td>
<td>-3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>I believe a good lecturer can teach concepts without educational technology.</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>28</td>
<td>I believe that today’s students learn differently than students did 25 years ago.</td>
<td>0</td>
<td>-2</td>
<td>2</td>
</tr>
<tr>
<td>33</td>
<td>I believe today’s students do not relate to an instructor talking for 50 minutes or longer.</td>
<td>0</td>
<td>-1</td>
<td>2</td>
</tr>
<tr>
<td>25</td>
<td>I like to listen to students to determine if they are grasping a concept.</td>
<td>5</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>47</td>
<td>I prefer pencil and paper over educational technology.</td>
<td>-3</td>
<td>-1</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>I feel that students who ‘tune out’ in class will do so whether or not educational technology is used.</td>
<td>-1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>I believe the use of educational technology hampers students’ critical thinking.</td>
<td>-2</td>
<td>-3</td>
<td>0</td>
</tr>
<tr>
<td>44</td>
<td>I think my college/institution supports the use of educational technology.</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>35</td>
<td>I believe using educational technology is necessary for students to be engaged in the learning process.</td>
<td>0</td>
<td>-4</td>
<td>-1</td>
</tr>
<tr>
<td>42</td>
<td>I think that using educational technology reduces the amount of student’s texting and daydreaming while in my class.</td>
<td>0</td>
<td>-4</td>
<td>-1</td>
</tr>
<tr>
<td>23</td>
<td>I believe that it is not worth my time outside of the classroom to learn to use educational technology.</td>
<td>-1</td>
<td>2</td>
<td>-4</td>
</tr>
</tbody>
</table>

Supporting Evidence of Epistemology from Survey Statements
Table 13 below shows the educational technology the participants use and how it is being used in their respective classrooms. The participants self-reported the educational technology they use and as a result “open” definition of educational technology used in this study these technologies varied greatly. Because of the variety and the subjective definitions of educational technology, the Factors that emerged developed along the epistemological views of the E-ET educators. The answers to the survey and post sort questions align with the distinguishing and most like statements for each factor.

Table 13

Educational Technology Used, Answer to Survey and Post-Sort Interview Questions

<table>
<thead>
<tr>
<th>Participant</th>
<th>Educational Technology</th>
<th>Classroom Activity</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETF46</td>
<td>Power Point, Panopto Course cast and personal website.</td>
<td>Maintains a publically accessible website for student downloads and course materials. Panopto recordings are available for student absences and review.</td>
<td>1</td>
</tr>
<tr>
<td>ETM57</td>
<td>Clickers, Overheads, Projectors, Videos, Internet, Computers, Software</td>
<td>Clickers-Reinforcement of learning. Computers-Industry standard technology. Overheads-course information. Internet-Course projects and student research.</td>
<td>1</td>
</tr>
<tr>
<td>ETM50</td>
<td>Clickers, Panopto, Lecture Capture, On-Line Classroom Management System, Web Applications</td>
<td>Clickers for concept testing and quizzes, Panopto for students to review and for future on-line course, On-Line Classroom Management System-for quick feedback and statistics.</td>
<td>1</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>EM52</td>
<td>Clickers, Power Point</td>
<td>Clickers-used for collaborative learning, peer to peer instruction, and checking if student grasp of concepts.</td>
<td></td>
</tr>
<tr>
<td>EM37</td>
<td>Tablet for Technology, Computer Model for simulations and Internet</td>
<td>Use HP Tablet to write on Power Point Slides, Demonstrate visually reactor scenarios w/software, Internet to find resources.</td>
<td></td>
</tr>
<tr>
<td>ETM66</td>
<td>Overhead Projector, Chalk, Board, &quot;Show and Tell&quot; of actual devices/equipment</td>
<td>Overhead with Handouts, demonstrating actual technology being taught.</td>
<td></td>
</tr>
<tr>
<td>ETM60</td>
<td>On-Line Classroom Management System, Power Point Presentations, e-mail, you tube specialized websites.</td>
<td>Post all course material on-line, Use Power Points, Demonstrate Interesting Links that relate to course subjects.</td>
<td></td>
</tr>
<tr>
<td>ETM45</td>
<td>Power Point, Computer Simulation Overhead Slides</td>
<td>I use technology to reduce the amount of time students write information in their notes and to demonstrate concepts. Students use simulations to predict and verify concepts.</td>
<td></td>
</tr>
<tr>
<td>EF44</td>
<td>Answered no to Question 1 (Does not use Educational Technology)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
**ETM48**  
Computers, Power Point with LCD projector, CNC simulation software, robotics simulation software, PLC simulation software, On-Line Classroom management System, Panopto Course Cast software, PLC robotic and CNC trainers.

**ETM65A**  
Computer software, electronic hardware, Internet Activities, Videos, programmed instruction, Internet, e-mail etc.

Most activities in my field require the use of state-of-the-art instruments and products.

**ETM64**  
Computer Projector, Overhead Projector, Videos, Internet, e-mail On-Line classroom Management System, MS Office Tools, AutoCAD, Inventor and Trilogi6

Description of software included specific course in which software was used. Common theme was all technology was use for demonstration.

---

**Response to Research Questions**

1. What educational technology, if any, are engineering/engineering technology educators using in their courses?

2. If engineering/engineering technology educators are using educational technology how is it being used in the educational?

3. What are the various views E-ET educators have about educational technology and its use in their courses?

4. What is the relationship between the use of educational technology and the views of engineering/engineering technology educators regarding the use of educational technology in their engineering/engineering technology courses?

---

**Results of Testing the Research Hypotheses**
The first research hypothesis stated that exploring the types of educational technology engineering/engineering technology educators use will reveal that a variety of educational technology is being used the engineering/engineering technology courses. The results from the Demographic and Educational Technology Survey did indeed reveal a variety of educational technology being used in E-ET disciplines. Table 13 shows the list of what educational technology is being used as self-reported by the participants and the participant self-reported statements of how of educational technology is being used in the course. Thus, this research hypothesis is accepted based on the above.

The second research hypothesis stated that the analysis of the Q-sort will reveal the different views on the use of educational technology that exist among engineering/engineering technology educators who use educational technology and those who do not use educational technology. The analysis of the Q-sort resulted in three factors. Factor 1 or what the researcher has named "Student Engagers". These educators are those who feel that it is important to engage the students in the learning process and view educational technology as a valuable tool in doing so. The two statements that help to define this factor are statement 32 (I believe the immediate feedback that educational technology provides allows the student to quickly gauge their level of understanding) and 31 (I think the immediate feedback that educational technology provides allows instructors to quickly gauge the effectiveness of their teaching). These statements indicate that these educators tend to think that being able to immediately gauge conceptual understanding is important for both the instructor and the student. This supposition is further supported by the written comment from participant ETM57 in response to post-sort questions 1(Why is you view most like the statement you placed under +5 (most like
“An instructor **Needs Feedback** from the student to ensure the student is grasping the concept.” ETM57’s +5 (most like my view) statement was statement 25 (I like to listen to students to determine if they are grasping a concept). ETM57 stated that clickers were used in the classroom as one method of acquiring this feedback. This instructor also indicated that clickers were used in during the lecture to both increase participation and as the chosen method to “listen” to the students to determine if they are grasping a concept. Participant EM52 further supported this idea by stating the reason he used educational technology in the classroom was to “Increase Active Learning, Objective Progress Assessment”. All of the participants who loaded on Factor 1 indicated in some fashion that increased student participation and the ability to immediately gauge conceptual comprehension were the main reasons that they made use of educational technology in their classrooms. See Table 13 below for the statements for each participant.

The participants who loaded on Factor 2 tended to be teacher-centered in their epistemology. These E-ET educators view educational technology as gadgets or gizmos as indicated by statement 18 (I think the use of educational technology teaches students to depend on gadgets) appearing in the six most like my view statements.

“The Entertainers” are not necessarily anti-educational technology. Statement 15 (I believe that there is no good way to use educational technology to augment teaching) appears in the six least-like my view statements (Table 7) and in fact all of these participants reported using educational technology in their courses. “The Entertainers” are not opposed to changing or adapting their approach to teaching as indicated by statement 21 (I feel my teaching style has been effective for years and I see no reason to
change my method if it is working) also appearing in the six least like my view table (Table 7). This indicates that the issue is not with the use of educational technology itself nor is the issue as refusal to improve their pedagogy.

The participants who loaded on Factor 2 have a teacher-centered pedagogy. This is supported by the both the distinguishing statements (Table 8) and the most like my view statements (Table 6) for this factor. It is further supported by the answers to the survey questions of how these participants used educational technology in the course. ETM66 reported that during class this participant uses overheads with handouts and demonstrations of the actual technology being taught. However, ETM66 made no mention of what the students are doing while the demonstration is occurring nor was anything mentioned about including the students in the demonstration, indicating a very passive learning pedagogy. EM37 reported that during class EM37 uses a tablet PC with Power Points, demonstrates of various scenarios with software, and Internet to find resources. EM37 stated “You have to engage the students on multiple levels, especially the lower classmen. You have to engage to the point of being entertaining.” The results of the Q-sort combined with this participant’s comments indicate that EM37’s view of engagement is being entertaining for the students to keep them paying attention during the lecture. Again, no mention of what the students are doing during while the entertaining is occurring. ETM60 responded to the port-sort question “Why is your view most like the statement placed under +5 (most like my view)?” by stating: “For weaker students it’s our challenge to inform motivate and keep on task. Otherwise, the students will tune out often.” All of these participants made use of what they defined as educational technology, but used it in a very traditional teacher-centered style based upon
their survey answers. Further supporting the teacher-centered supposition is that there was no mention in their self-reporting about what the students were doing during the lecture. These educators’ views on student attitudes are evidenced by statement 13 (I feel that students who ‘tune out’ in class will do so whether or not educational technology is used) appearing in both the six most like my view table (Table 6) and in the distinguishing statements table (Table 8). This indicates that “The Entertainers” believe that if they are animated enough and have adequate demonstrations, they can keep the attention of the “daydreamers” and “weaker” students regardless of whether or not educational technology is involved. In other words, entertainment leads to student engagement and that is solely the responsibility of the instructor.

Those represented by the Factor 3 view, “This is how I learned”, tend to see some value in using educational technology, however had a very traditional teacher-centered on how students learned. These educators tend to see some value in using educational technology, however they had a very traditional teacher-centered on how students learned. This is supported by statement 5 (I believe that students best learn concepts through repetition and practice), statement 4 (I believe a good lecturer can teach concepts without educational technology) statement 37 (I believe students have to take notes to learn) and statement 40 (I prefer to use educational technology as a supplement to the lecture) appearing in the six most like my view table (Table 10). All of these statements represent a traditional teacher-centered type of pedagogy.

Three of these Factor 3 representatives viewed using any kind of technology as educational technology. In other words, because they taught students how to use technology, they viewed the Q statements as relating to industry standard
technology or the technology tools used in their respective fields such as design software
used in mechanical engineering. ETM65A’s primary concern is that graduates of this
particular program are able to use the tools they will use on the job. In all of ETM65A’s
responses, there was neither mention of conceptual understanding of the material being
presented nor any mention of student engagement in the classroom. ETM64, ETM48 and
ETM 45 all provided very similar responses to the survey questions. All four of these
participants used Power Point and industry standard technology in their courses primarily
in a teacher-centered, demonstrative fashion. Further, during a post-sort personal
conversation with ETM65A, this participant stated that there are tried and true methods
that are known to work. ETM65A used technology as a supplement to those tried and true
methods, but has not adopted a more student-centered approach to teaching. EF 44 was
the only participant who did not use educational technology at all.

Further defining this factor as “This is how I learned” is statement 47 (I prefer
pencil and paper over educational technology) and statement 2 (I believe the use of
educational technology hampers students’ critical thinking) appearing in the
distinguishing statements. EF44 stated the reason for placing statement 5 (I believe that
students best learn concepts through repetition and practice) in the +5 (most like my
view) position on the sorting grids as “Regardless of the activity (learning an engineering
concept, musical instrument, language, sport, etc.) best way to obtain expertise is through
practice.” ETM64 also ranked statement 5 at +5 on the grid. ETM64 stated “I am very
Deweyan (referring to John Dewey). We learn by doing. We perfect by practicing. If I
can get a student to willingly practice, positive results are almost guaranteed.” This
reason is very similar to EF44’s reason for placing the statement in the +5 (most like my
view) grid position in that they both support the traditional teacher-centered idea that repetition and practice is the best way to learn. Similar to Factor 2, none of the participants who loaded on Factor 3 made any mention of what the students were doing during the lecture nor was there any mention of how the students were engaged with the educational technology being used in the class, if educational technology was used at all. These educators seem to share the philosophy that it is their role to present the material and that conceptual understanding, which is the responsibility of the student, is best achieved through repetition and practice. The use or non-use of educational technology was not tied to student conceptual understanding by those E-ET educators who loaded on this factor.

Summary

The participants in this study were chosen to represent a variety of E-ET disciplines which included Electrical Engineering, Electronic Engineering Technology, Civil Engineering, Construction Engineering Technology, Surveying Engineering Technology, Mechanical Engineering Technology, and Automated Manufacturing Engineering Technology. There were fourteen participants who returned The DETUS and Q-sort materials. The DETUS revealed a variety of educational technology being used in E-ET courses. The Q-sort process revealed three factors or views on the use of educational technology in E-ET courses. The factors were named “Student Engagers”, “The Entertainers” and “This is how I learned” by the researcher in order to describe the views expressed by these factors. The names for the factors were determined by the answers provided on the DETUS, the results of the Q-sort and answers to the post-sort questions. The “Student Engagers” were very student-centered both their pedagogy and
in their use of educational technology while “The Entertainers” and the “This is how I learned” factors were both very teacher-centered in both their pedagogy and in their use of educational technology.
CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Restatements of the problem, procedures, and specific research hypotheses begin the chapter. Conclusions are drawn from the Chapter IV analyses. The implications followed by the suggested future research are also contained in this chapter.

Summary of the Study

Predominately, the pedagogy currently found in engineering/technology education is the engineering science model developed during the 1950’s as a reaction to the cold war. The engineering science education model moved away from the apprentice/hands on model that was prevalent before World War II and toward the lecture/teacher-centered model during this period (Kenyon, 1993; Michko, 2007, 2008). This teacher-centered model has also been called the chalk and talk method of teaching (Mills & Treagust, 2003). The teacher-centered chalk and talk model generally involves limited student engagement. While student engagement alone is not the goal of educational technology, it is an important step along the way to the ultimate goal of student achievement. Educational technology offers E-ET educators the opportunity to move beyond that traditional model and increase student engagement (Mills & Treagust, 2003; Bowe, 2010; Nicholas, 2010a).

Despite the potential to improve the pedagogy in engineering/technology education by implementing educational technology into
engineering/engineering technology (E-ET) courses, there is a high level of resistance
toward doing so by engineering/engineering technology educators (Michko, 2007, 2008; Bowe, 2010). This study investigated the views of E-ET educators on the use of
educational technology in E-ET courses. Q Methodology was used as the research
method because it is designed to measure the participants’ subjectivity or various views
on a subject (Brown 1980, 1993; McKeown & Thomas, 1988). In this case investigating
the subjective views led to three factors (distinct views) about E–ET educators on the use
of educational technology in E-ET education.

The views or factors that emerged from the Q-sort process were evaluated while
considering participant demographic information and educational technology use for
several initial participant variables. These participant variables were the use of
educational technology in E-ET courses, engineering educator, engineering technology
educator self-reported age in years, self reported time-in-service in years,
teaching load, graduate status, gender, race, institution and department. This investigation
used the demographic information and compared it to the factor upon which a participant
loaded to determine, what, if any, correlation there might be between any of the
demographic information and the factor loading.

Statement of the problem

Educational technology has become commonplace in education, particularly in
the K-12 educational (Bowe, 2010). However, its implementation has lagged in higher
education, including E-ET education (Michko, 2007, 2008; Bowe, 2010). Engineering
education is defined as the activity of teaching engineering at college or university level
preparing the graduate for a profession as a practicing engineer. Engineering Technology
education defined as the activity of teaching the applied aspects of science and engineering preparing graduates for practice in that portion of the technological spectrum closest to product improvement, industrial processes, and operational functions (ABET, 2010).

There is potential to improve the pedagogy of faculty within E-ET by implementing educational technology into E-ET courses, yet there is a high level of resistance toward doing so by engineering/engineering technology educators (Michko, 2007, 2008; Bowe, 2010). This study investigated the views of E-ET educators on the use of educational technology in E-ET courses. Q Methodology was used as the research method because it is designed to measure the participants’ subjectivity or views on a subject (Brown 1980, 1993; McKeown & Thomas, 1988). In this case the subjectivity measured was the views of E–ET educators on the use of educational technology in E-ET education.

The purpose of this study was to investigate the subjectivity/views of engineering and engineering technology educators at a public Midwestern university regarding the use of educational technology in E-ET courses. Educational technology is defined for this study as both hardware and software used by an instructor for teaching, a student for learning, or both instructor and student. Two examples of educational technology are Classroom Response Systems (clickers) and on-line educational management tools. Clickers consist of transmitters that students use to send responses, receivers that are connected to a computer that collects these responses. The computer runs software designed to interpret and aggregate these responses in real time (Fies & Marshall, 2006). The instructor has a choice as to how publicly or how anonymously these responses are
collected and displayed. The aggregated responses are almost always publicly displayed to inform both instructors and learners of the overall distribution of selections (Fies & Marshall, 2006; Kraft, 2007; Nicholas, 2009, 2010).

Statement of the procedures

During the spring semester 2011, participants were administered a Demographic and Educational Technology Usage Survey (DETUS) in conjunction with a Q-sort packet, which included the Q-sample, sorting grid and the conditions of instruction. The DETUS was used to collect the participating E-ET educators’ general demographic information as well as what, if any, educational technology they use in their courses and how educational technology is used if they do use it. The Q-sort was used to discover why the E-ET educators used educational technology as well as the educators' pedagogy and epistemology.

The specific research hypotheses

Specific Research Hypothesis 1A

The survey instrument will reveal what types of educational technology are being used in engineering/engineering technology courses.

The survey instrument allowed the participants to self-reports and self-define educational technology. Thus, this hypothesis is supported by the data collected from the survey. Table 13 below shows the educational technology used as reported by the participants of this study.

Specific Research Hypothesis 1B

The survey instrument will reveal how educational technologies are being used in engineering/ engineering technology courses.
This hypothesis is supported by the data analysis. Table 14 shows what educational technology is being used in the E-ET and how educational technologies are being used in the E-ET courses of the participants of this study. Each respondent self-reported what educational technology is being used and what technology is being used in their respective courses.

Table 14

Educational Technology and Answer to survey and Interview Questions

<table>
<thead>
<tr>
<th>Participant</th>
<th>Educational Technology</th>
<th>Classroom Activity</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETF46</td>
<td>Power Point, Panopto Course cast and personal website.</td>
<td>Maintains a publically accessible website for student downloads and course materials. Panopto recordings are available for student absences and review.</td>
<td>1</td>
</tr>
<tr>
<td>ETM57</td>
<td>Clickers, Overheads, Projectors, Videos, Internet, Computers, Software</td>
<td>Clickers-Reinforcement of learning. Computers-Industry standard technology. Overheads-course information. Internet-Course projects and student research.</td>
<td>1</td>
</tr>
<tr>
<td>ETM50</td>
<td>Clickers, Panopto, Lecture Capture, On-Line Classroom Management System, Web Applications</td>
<td>Clickers for concept testing and quizzes, Panopto for students to review and for future on-line course, On-Line Classroom Management System-for quick feedback and statistics.</td>
<td>1</td>
</tr>
</tbody>
</table>
EM52 Clickers, Power Point
Clickers-used for collaborative learning, peer to peer instruction, and checking if student grasp of concepts.

EM53 On-Line Classroom Management System, Personal Computers
On-Line Classroom Management System-Class information management, homework submission, communication with the class. Personal Computers-in class computational exercises.

EM37 Tablet for Technology, Computer Model for simulations and Internet
Use HP Tablet to write on Power Point Slides, Demonstrate visually reactor scenarios w/software, Internet to find resources.

ETM66 Overhead Projector, Chalk, Board, "Show and Tell" of actual devices/equipment
Overhead with Handouts, demonstrating actual technology being taught.

ETM60 On-Line Classroom Management System, Power Point Presentations, e-mail, you tube specialized websites.
Post all course material online, Use Power Points, Demonstrate Interesting Links that relate to course subjects.

ETM45 Power Point, Computer Simulation Overhead Slides
I use technology to reduce the amount of time students write information in their notes and to demonstrate concepts. Students use simulations to predict and verify concepts.

EF44 Answered no to Question 1 (Does not use Educational Technology)

ETM48 Computers, Power Point with LCD projector, CNC simulation software, robotics simulation software, PLC simulation software, On-Line Classroom management System, Panopoto Course Cast software, PLC robotic and CNC trainers.
Computers, Power Point LCD Projector and Panopoto to support lectures. Simulation and Training software for demonstrating and practicing course concepts. On-Line Classroom Management System for managing class and disseminating course material.
ETM65A  Computer software, electronic hardware, Internet Activities, Videos, programmed instruction, Internet, e-mail etc.  
Most activities in my field require the use of state-of-the-art instruments and products.

ETM64  Computer Projector, Overhead Projector, Videos, Internet, e-mail On-Line classroom Management System, MS Office Tools, AutoCAD, Inventor and Trilogi6  
Description of software included specific course in which software was used. Common theme was all technology was use for demonstration.

Specific Research Hypothesis 2A

The views on the use of educational technology of the engineering/engineering technology educators who use educational technology will differ from those who do not use educational technology. The researcher could not reject the null hypothesis as EF44 who does not use educational technology of any kind loaded on factor 3 with ETM65A, ETM 45 and ETM48, all of whom use educational technology of some kind in their classroom. Factor 3 was named “This is how I learned” as those educators possessed a traditional teacher-centered epistemology and their use of educational technology was geared more toward teaching students how to use industry standard technology as opposed to using technology to engage the students. Thus, the researcher could not reject the null hypothesis.

Specific Research Hypothesis 2B

The views on the use of educational technology of the engineering educators will differ from engineering technology educators. This research hypothesis is also not true as the result showed no difference between the views on the use of education technology between engineering and engineering technology educators. This is evidenced by the fact
that both engineering and engineering technology educators loaded on two factors (Factor 1 and Factor 3). Had there been a difference in the views of engineering and engineering technology educators the factors would have contained only engineering educators or only engineering technology educators. Thus, this hypothesis is rejected.

Conclusions

Participant Responses to Post-Sort Questions and Interviews

There were two post-sort interview questions asked on the Q sort sheet. The two questions were designed to elicit the sorters’ reason for choosing the statements placed at each end of the Q sort grid, -5 and +5 for this study. The two questions are as follows:

1) Why is your view most like the statement you placed under +5 (most like my view)?
2) Why is your view least like the statement you placed under -5 (most like my view)?

In addition to the two post-sort questions, there was an open ended statement asking the sorter to make any comment on their personal decision making process used during the sort.

The answers to these questions and statements were used in conjunction with the Q-sort results to gain further insights into the use of educational technology in E-ET education that may not have been revealed with the sort. The answers to the questions were also used to gain further insight into the view on the use of educational technology by each individual sorter. This allowed the researcher to explore each factor more deeply.

First General Research Hypothesis
Exploring the types of educational technology engineering/engineering technology educators use will reveal that a variety of educational technology is being used in the engineering/engineering technology courses.

In this study faculty revealed that they use a variety of educational technologies being used emerged. The participants self-reported the educational technology being used and because of this the definition of educational technology varied from participant to participant. Table 13 above shows the educational technology self-reported by the participants.

Second General Research Hypothesis

The analysis of the Q-sort will reveal the different views on the use of educational technology that exist among engineering/engineering technology educators who use educational technology and those who do not use educational technology.

In this study, different views on the use of educational technology were revealed by analyses of the Q-sorts. However, the views that emerged did not result in pro- and anti-educational technology as might have been expected. The different views on the use of educational technology that were revealed by the Q-sort were split along pedagogical and epistemological lines. The pedagogical differences were defined by those educators who are student-centered (Factor 1 “Student Engagers”) versus those who are teacher-centered (Factor 2 “The Entertainers” and Factor 3 “This is how I learned”). Factor 1 (“Student Engagers”) viewed the use of educational technology as an opportunity for students to take on a more active and/or participatory role in their classroom and thus their learning. Factor 2 (“The Entertainers”) representatives, all of whom defined educational technology very differently, viewed the use of educational
technology as a way to help them hold the students attention, which is also how they viewed the word ‘engagement’—as holding the students attention. Factor 3 (“This is how I learned”), had one participant who did not use any technology in the classroom (EF44). EF44 felt that students learned concepts through repetition and practice and that educational technology does not help students learn E-ET concepts. The other Factor 3 representatives defined using educational technology as teaching students how to use the technology of their respective disciplines. Those educators who loaded on Factor 2 and Factor 3 who did report using technology, used it in a very traditional teacher-centered fashion as evidenced by ETM66 (Factor 2) reporting that during class this participant uses overheads with handouts and demonstrations of the actual technology being taught. ETM66 made no mention of what the students are doing while the demonstration is occurring. EM37 (Factor 2) reported that during class this participant uses HP tablet with Power Points, demonstrates scenarios with software, and uses the Internet to find resources. EM37 stated “You have to engage the students on multiple levels, especially the lower classmen. You have to engage to the point of being entertaining.” This indicates that EM37’s view of engagement is being entertaining. Again, no mention of what the students are doing during while the entertaining is occurring. For Factor 3, tend to see some value in using educational technology, however had a very traditional teacher-centered on how students learned. This is supported by statement 5 (I believe that students best learn concepts through repetition and practice), statement 4 (I believe a good lecturer can teach concepts without educational technology) statement 37(I believe students have to take notes to learn) and statement 40 (I prefer to use educational technology as a supplement to the lecture) appearing in the six most like my view table of
this factor. All of these statements represent a traditional teacher-centered epistemology. To further clarify these views, future research should be conducted investigating each factor more in depth.

**Implications**

This section contains the implications of the research. The literature review led to several research questions addressed by this study. There are at least three reports that call for a change in the teaching curriculum (BEST, 2004; National Academy of Engineering, 2004; National Academy of Engineering, 2005). All three of these reports intimate that the new educational technologies can be important tools in increasing efficiency and effectiveness of engineering education. Despite calls for implementing educational technology into undergraduate engineering courses by Building Engineering and Science Talent (BEST), The American Society of Engineering Educators (ASEE), and ABET Incorporated (formerly known as the Accreditation Board for Engineering and Technology) and other influential organizations, there has been some reluctance to use educational technology in undergraduate engineering courses (Michko, 2007). This study provides a beginning to understanding this reluctance in implementing the use of educational technology into engineering education courses. Understanding the views of engineering/engineering technology educators on the use of educational technology will help to identify the barriers that exist in the implementation of educational technology in E-ET courses. Once the barriers to the implementation of educational technology are identified, steps can be taken to help these educators improve their pedagogy and adopt educational technology in order to lay the foundation for technology integration for learning. These questions led to a study that was different from prior studies.
studies, discussed in the literature review, were limited in scope, looked educational at higher education as a whole or were meta-analyses of the use of industrial standard technology in engineering education. In these ways, the studies discussed were flawed and, therefore, open to criticism. This study was different in that it:

1. examined what educational technologies are being used specifically in E-ET education as defined by the participants.
2. examined how educational technology was being used in E-ET courses of the participants.
3. investigated the views of the participants on the use of educational technology in E-ET education.
4. investigated the pedagogical epistemologies of the participants as it relates to E-ET education.

Thus, this study provides an in depth look not only into what educational technologies are being used in E-ET courses, but why the participants use these educational technologies and how the participants of the study are using these educational technologies.

This study indicates that the reluctance to implement educational technology in E-ET courses is not necessarily a reluctance to use educational technology, but that the reluctance is based more upon 1) the pedagogy of the educator and 2) the epistemology of the educator. Those E-ET educators who were teacher-centered in their pedagogy used classroom technology more as a way to demonstrate the use of tools or as an enhancement to the traditional lecture-take notes style of teaching rather than to lead students in guided inquiry or to increase student participation during the lecture. This indicates that the reluctance lies in the epistemologies of these E-ET educators as their
pedagogy maintains the teacher-centered model whether or not educational technology is used. Where the previous studies indicated a reluctance to use educational technology, the factors that emerged from the Q-sort indicate that the reluctance is more epistemologically based as opposed to technology based.

Understanding these pedagogies and epistemologies can help to implement the technological pedagogical content knowledge (TPACK) framework as developed by Mishra and Koehler into E-ET courses. The TPACK framework strives to find the overlap between Technological implementation, Content Knowledge and Pedagogical Knowledge. The factors in arising from the Q-sort along with the answers post-sort interview questions indicate that while the definition of educational technology varied among the participants, only three distinct views emerged that define the views of the participants on the use of educational technology in E-ET courses. Factor 1 (“Student Engagers”) viewed educational technology as a way to engage students in a collaborative, active learning fashion. These educators tended to be more student-centred in their pedagogy. These educators used educational technology primarily for receiving immediate feedback on student comprehension and to keep the class interactive. Factor 2 (“The Entertainers”) also were concerned with student engagement, but from a more teacher-centered pedagogy. This was evidenced by their use of educational technology to demonstrate to the student as opposed to increase student participation. These educators felt in order to keep the students paying attention they had to entertain them and saw educational technology as a method of doing so. Factor 3 (“This is how I learned”), also concerned with student engagement, and also from a teacher-centered pedagogy, saw the use of educational technology as a modern tool for the traditional practice-and-repetition
oriented pedagogy. These educators also mentioned using educational technology for demonstrating concepts to the students. These educators defined educational technology as any technology they used in their courses, including industry standard technology for their respective fields. Thus, where they did include and encourage student participation, it was to allow the students to practice on the equipment they will likely encounter in the workplace and not as a method to gauge conceptual understanding in the students.

The factors arising from this Q study could help to shape, along with the other tools and measurements, the most appropriate and effective use of educational technology and curricular development so engineering/engineering technology education remains relevant and effective for the 21st century learner.

Suggested Further Research

A variety of additional, unanswered questions arose while conducting this study. For instance, if the Q-sort and DETUS were conducted at multiple institutions, would there have been more and/or different factors? Because Q Methodology is not generalizable to the larger population, studies that include multiple institutions where E-ET education occurs may result in a richer understanding of the barriers that may exist in implementing educational technology into E-ET education at the different institutions. Further, a study that focuses more on the actions of E-ET educators while teaching in the classroom period may prove insightful. This type of qualitative investigation may lead to a more detailed analysis of why some educators make frequent use of educational technology while others do not. A more intimate dialogue between the educators and researcher may also lead to other statements or insights relating to the views on the use of educational technology in E-ET courses. In other words, a Q-sample targeting other
questions from this study may lead to new insights. Including more questions in the
survey and/or statements on the pedagogical views of the E-ET educators and the
epistemologies of the educators may further result in further clarification of the factors.
Further, studies to determine which of these technologies and pedagogical methods have
the greatest impact on conceptual understanding of E-ET students can be conducted to
help implement the TPACK framework in E-ET courses. A study can be conducted that
has a Q-sample that is balanced such that so many statements per category in TPACK
model can be used to help determine where and how educational technology can be used
in E-ET course. Finally, exploring the amount of time that E-ET educators spend on
learning about and improving teaching methods and how students learn may reveal more
factors, more clearly define the pedagogy and/or more clearly define the epistemologies
of the E-ET educators in the study is warranted.

Summary

Chapter V began with a summary of the purpose and restatement of the problem.
The Q sort Process revealed 3 Factors on the views of E-ET educators on the use of
educational technology in E-ET education. They were the “Student Engagers” or those
who used educational technology to help the student be more active or participatory in
their learning, Future research should include interviews with more E-ET educators
including E-ET educators at more than one institution, classroom observations to
determine what educational technology may be appropriate for a specific course, and
studies that compare a treatment group with an experimental group to determine if using
educational technology as an intervention will have a positive outcome on conceptual
learning in E-ET education.
Further, studies to determine which of these technologies and pedagogical methods have the greatest impact on conceptual understanding among E-ET students can be conducted to help measure the growth of TPACK in the E-ET educators who have implemented the TPACK framework. Finally, exploring the amount of time that E-ET educators spend on learning about and improving teaching method and how students learn may reveal more factors or more clearly define the pedagogy of the E-ET educators in the study is warranted.
REFERENCES


Bowe, R. (2010) Instructional Technology Adoption Amongst College of Education Faculty: A 5-Year Phenomenological Case Study (Dissertation)


Lasry, N. (2008), Clickers or Flashcards: Is there really a difference? The Physics Teacher, 46, 242-244.


APPENDIX 1: Q Statements from Pilot Study

1. I don’t think I need classroom technology to make my teaching more effective.

2. I believe the use of classroom technology hampers students’ critical thinking.

3. I believe using classroom technology encourages students to look only for answers and ignore the problem solving process.

4. I believe a good lecturer can teach concepts without classroom technology.

5. I believe that student’s best learn concepts through repetition and practice.

6. I feel that by encouraging open feedback and discussion in a classroom setting students will openly respond.

7. I believe when classroom technology is used it encourages students to respond to questions.

8. I like to try new ideas to improve my teaching.

9. I think most students enjoy using classroom technology.

10. I think classroom technology can be used to reinforce the learning of concepts to supplement lab activities.

11. I think the learning of concepts can only take place in the laboratory.

12. I believe using classroom technology helps students to remain engaged in the lecture when they would not be otherwise.

13. I feel that students who ‘tune out’ in class will do so whether or not classroom technology is used.
14. I believe that I am focused on improving student's learning in my courses.

15. I believe that there is no good way to use classroom technology to augment teaching.

16. I feel that classroom technology only teaches students to use shortcuts.

17. I think that students do not learn the fundamentals needed to be a good engineer when classroom technology is used.

18. I think the use of classroom technology teaches students to depend on gadgets.

19. I do not like to use classroom technology.

20. In general, I like all kinds of technology.

21. I feel education-based technology has no place in the engineering / engineering technology classroom.

22. I like the traditional lecture method of teaching best.

23. I believe that it is not worth my time outside of the classroom to learn to use classroom technology.

24. I believe using computer-based simulations helps students understand concepts.

25. My favorite technology is a piece of graph paper.

26. I feel students will not be prepared for the FE/PE exam if classroom technology is used.

27. I believe that today’s students learn differently than students did 25 years ago.

28. I believe classroom technology allows the instructor to engage students in their learning during class-time.
29. I feel that classroom technology allows me to provide more hands on experiences for students in the classroom.

30. I feel that classroom technology allows me to provide more hands on experiences for students in the classroom.

31. I think the immediate feedback that classroom technology provides allows instructors to quickly gauge the effectiveness of their teaching.

32. I believe the immediate feedback that classroom technology provides allows the student to quickly gauge their level of understanding.

33. I believe students have a shorter attention span today than we did when I was in school.

34. I believe today’s students do not relate to an instructor talking for 50 minutes or longer.

35. I think that the traditional style of lecturing will no longer work in teaching students.

36. I believe technology in the classroom is necessary for students to be engaged and learn.

37. I think students need to be exposed to a wide variety of technologies in the classroom and laboratory.

38. I believe students have to take notes to learn in the classroom.

39. I don’t feel clicker’s aid students’ learning.

40. I don’t believe that on-line classroom management tools (like Springboard!) aid students’ learning.

41. I prefer to use classroom technology as a supplement to the lecture.
42. I believe students like having access to course materials on-line.

43. I think students like to access course materials online because it is convenient and this helps them reinforce their learning.

44. I think that using classroom technology reduces the amount of student’s texting and daydreaming while in my class.

45. I think of technology as a way to minimize ‘human photocopying’ meaning students are merely copying what I am writing on the board / Power Point / overhead.

46. I believe that by keeping the students engaged in the lecture with technology I can more easily help them to develop the critical thinking skills needed to be an effective engineer / technician / technologist.

47. I think my college/institution supports the use of classroom technology.

48. I think that students prefer the traditional lecture and take notes method of instruction.
APPENDIX 2: Questions used in Interviews

Interview Questions –Pilot Study 2010

1. Describe your classroom… what are you doing during class time?

2. What are students doing?

3. Would you describe your teaching style as teacher-centered or student-centered?

4. In your opinion, how do students learn?

5. In your view, what does it mean to be technology savvy?

6. How do you feel technology applies to the classroom (in general)?

7. How do you believe technology be used effectively in the classroom?

8. How do you use technology in your classroom?

9. Are you familiar with classroom technologies such as Classroom Responses Systems (clickers), Smart Boards or on-line classroom management systems such as Springboard?

10. If yes, do you use them in your classroom?

11. If yes, what technologies do you use?

12. How are you using them?

13. If 8 = no, why?

14. If 8 = no, would you use these technologies if you knew more about them?
15. There exists an educations framework called Technological Pedagogical Content Knowledge or TPACK. Are you familiar with this framework?

16. If yes, are you implementing TPACK how are you doing it?

17. What are the barriers, if any, to using technology in your classroom?

18. How does your department… college… university support technology use in the/ your classroom?

19. If your institution provided training/more training on the use of classroom technologies would you be more likely to use them?

20. Do you think that students would like to have more technology in the classroom?

21. What classroom activities are more effective than technology, in your view?

22. Do you think any of those activities could be enhanced by using classroom technology?
APPENDIX 3: Demographic and Educational Usage Survey

Demographic and Educational Technology Survey

**Demographic Information:**

1) Field in which you teach: ________________________________________________

2) How long have you been teaching? _________________________________

3) How many load hours do you typically teach in a semester? _________

4) Do you maintain grad status I or II? Please indicate specifically which one, if applicable.

________________________________________________________________________

6) Gender: M/F (circle)

7) Age: __________

**Educational Technology Usage**

1) Do you use educational technology such as clickers, on-line classroom management or a Smartboard? ________________

2) If yes to number 1, what are you using (please list any education related technology you are using)?

________________________________________________________________________

________________________________________________________________________

3) If yes to number 1, briefly describe how the educational technology is being used?

________________________________________________________________________

________________________________________________________________________
4) If you are not using educational technology, are you planning to begin doing so soon?

Why or Why Not?

________________________________________________________________________

5) If you are not using educational technology, what is the primary reason (e.g. personal preference, departmental barriers, etc.)?

________________________________________________________________________

________________________________________________________________________

6) Do you use technology outside of the classroom?______________________________

7) If yes to 6, what types of technology do you use? (e.g. computer, cell/smart phone, field related, etc.)

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
APPENDIX 4: Q sample for Dissertation

1. I don’t think I need educational technology to make my teaching more effective.
2. I believe the use of educational technology hampers students’ critical thinking.
3. I believe using educational technology encourages students to look only for answers and ignore the problem solving process.
4. I believe a good lecturer can teach concepts without educational technology.
5. I believe that student’s best learn concepts through repetition and practice.
6. I feel that by encouraging open feedback and discussion in a classroom setting students will openly respond.
7. I believe when educational technology is used it encourages students to respond to questions.
8. I like to try new ideas to improve my teaching.
9. I think most students enjoy using educational technology.
10. I think educational technology can be used to reinforce the learning of concepts to supplement lab activities.
11. I think the learning of concepts can only take place in the laboratory.
12. I believe using educational technology helps students to remain engaged in the lecture when they would not be otherwise.

13. I feel that students who ‘tune out’ in class will do so whether or not educational technology is used.

14. I believe that I am focused on improving student's learning in my courses.

15. I believe that there is no good way to use educational technology to augment teaching.

16. I feel that educational technology only teaches students to use shortcuts.

17. I think that students do not learn the fundamentals needed to be a good engineer when educational technology is used.

18. I think the use of educational technology teaches students to depend on gadgets.

19. I do not like to use educational technology.

20. I feel education-based technology has no place in the engineering / engineering technology classroom.

21. I feel my teaching style has been effective for years and I see no reason to change my method if it is working.

22. I like the traditional lecture method of teaching best.

23. I believe that it is not worth my time outside of the classroom to learn to use educational technology.

24. I find educational technology more effort than it is worth to learn.

25. I like to listen to students to determine if they are grasping a concept.

26. I believe it is important to offer multiple teaching methods during class.
27. I feel students will not be prepared for the FE/PE exam if educational technology is used.

28. I believe that today’s students learn differently than students did 25 years ago.

29. I believe it is important to engage current students in doing a task related to the concept.

30. I believe educational technology allows the instructor to better engage students in their learning.

31. I think the immediate feedback that educational technology provides allows instructors to quickly gauge the effectiveness of their teaching.

32. I believe the immediate feedback that educational technology provides allows the student to quickly gauge their level of understanding.

33. I believe today’s students do not relate to an instructor talking for 50 minutes or longer.

34. I think that the traditional style of lecturing is not an effective way to teach today's students.

35. I believe using educational technology is necessary for students to be engaged in the learning process.

36. I think students need to be exposed to a wide variety of technologies in the classroom and laboratory.

37. I believe students have to take notes to learn.

38. I don’t feel educational technology aid students’ learning.

39. I like to use technology in my day to day life (home).
40. I prefer to use educational technology as a supplement to the lecture.

41. I think students like to access course materials online because it is convenient and this helps them reinforce their learning.

42. I think that using educational technology reduces the amount of student’s texting and daydreaming while in my class.

43. I think of educational technology as a way to minimize ‘human photocopying’ meaning students are merely copying what I am writing on the board / Power Point / overhead.

44. I think my college/institution supports the use of educational technology.

45. I believe that by keeping the students engaged in the lecture with educational technology I can more easily help them to develop critical thinking skills.

46. I believe that students prefer the traditional lecture and take notes method of instruction.

47. I prefer pencil and paper over educational technology.

48. I like to use technology for my engineering/engineering technology work.
APPENDIX 5: Human Subjects Information
February 10, 2011

John R. Nicholas
Business Technology
The University of Akron
Akron, Ohio 44325-6602

From: Sharon McWhorter, IRB Administrator

Re: IRB Number 201102/01 “Investigating Engineering Educators’ Views on the Use of Classroom Technology”

Thank you for submitting your IRB Application for Review of Research Involving Human Subjects for the referenced project. Your application was approved on February 9, 2011. Your protocol represents minimal risk to subjects and matches the following federal category for exemption:

☐ Exemption 1 - Research conducted in established or commonly accepted educational settings, involving normal educational practices.

☐ Exemption 2 - Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior.

☐ Exemption 3 - Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior not exempt under category 2, but subjects are elected or appointed public officials or candidates for public office.

☐ Exemption 4 - Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens.

☐ Exemption 5 - Research and demonstration projects conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine public programs or benefits.

☐ Exemption 6 - Taste and food quality evaluation and consumer acceptance studies.

Annual continuation applications are not required for exempt projects. If you make changes to the study’s design or procedures that increase the risk to subjects or include activities that do not fall within the approved exemption category, please contact me to discuss whether or not a new application must be submitted. Any such changes or modifications must be reviewed and approved by the IRB prior to implementation.

Please retain this letter for your files. This office will hold your exemption application for a period of three years from the approval date. If you wish to continue this protocol beyond this period, you will need to submit another Exemption Request. If the research is being conducted for a master’s thesis or doctoral dissertation, the student must file a copy of this letter with the thesis or dissertation.

☐ Approved consent form/s enclosed

Cc: Susan Rutter - Advisor
Cc: Stephanie Woods - IRB Chair

Office of Research Services and Sponsored Programs
Akron, OH 44325-2102
330-972-3900 - 330-972-2231 Fax

The University of Akron is an equal opportunity employer and affirmative action institution.
You are invited to participate in a study being conducted by John B. Nicholas, Assistant Professor of CIS, Department of Business Technology, Summa College, and Doctoral Candidate in the College of Information at the University of Akron, Akron, OH. The project investigates the views of engineering and technology educators on the use of classroom technology in engineering and technology classrooms. The project includes a Demographic and Classroom Technology Survey and a Q-Sort. Analysis of engineering/technology educators' views will be done using the Q-sort methodology analysis technique.

Should you agree to participate you are expected to complete the Demographic and Classroom Technology survey and to perform the Q-Sort to be about 30-60 minutes. If you are under the age of 18, you must have your legal guardians' permission to participate. Do you have any further clarification about your role or should I have any further questions for you?

The Demographic and Classroom Technology survey and the Q-Sort will be conducted at a time mutually agreed upon by the participant (you) and the researcher during the Spring 2011 semester at a location that is suitable for you. If you agree to participate, you may refuse to answer any questions and may withdraw from the study at any time. Everyone is asked to return the package containing the questionnaire and Q-Sort, so there is no way of identifying who completed it and who did not complete it.

Completion of the Demographic and Classroom Technology survey and the Q-Sort will serve as your consent to participate in this study. You may keep this form for your records. Participants' answers to the questionnaire will be recorded, without any identifying information, and used only by the researcher for the purposes described above. Your confidentiality will be protected throughout the study. Any data obtained from you (whether in the survey or Q-Sort) will be kept confidential and will not be shared with anyone other than the researcher. All identifying information will be retained in a locked cabinet or other locked storage area. The data will be kept for not more than two (2) years and will be destroyed upon completion of the project. There are no anticipated benefits to you as a participant.

If you have any questions about the research project, you can call me at 330-972-5570 or e-mail me at johnnicholas@summa.edu. This research project has been reviewed and approved by The University of Akron Institutional Review Board for the Protection of Human Subjects. Questions about your rights as a research participant can be directed to Dr. Sharon K. Whetstone, Associate Director, Research Services, at 330-972-7000.

Thank you for your participation.

Sincerely,
John B. Nicholas
Assistant Professor of CIS
Department of Business Technology
The University of Akron

Department of Business Technology
Summit College
Akron, OH 44325-6002
230-972-7113 Office; 230-972-5570 Fax
The University of Akron

145