PREPARING PRE-SERVICE TEACHERS
AND TECHNOLOGY LITERACY

By

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Abstract

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Over the last thirty years, policy makers and education reformers have expressed the need for integrating technology into K-12 education. Policies developed by current legislation and accreditation organizations dictate that pre-service teachers need to be technology literate. However, there is no conclusive research on the most effective method of providing technology literacy skills. This study used a descriptive case study design to take an in-depth look at how an exemplary teacher education program teaches technology literacy using Mishra and Koehler’s TPACK framework for incorporating technology instruction into teacher education programs (2006). The Educating Teachers Report: Educating School Teachers (Levine, 2006) has identified the top teacher preparation programs in the United States. Of these exemplary institutions, one Teacher Preparation Program was noted as an exemplary institution in the preparation of pre-service teachers in technology literacy. The data were gathered from interviews of faculty and graduate instructors, observations of content and technology courses, and document analysis of course syllabi. The data gathered was reviewed under the lens of the Technological Pedagogical Content Knowledge framework and compared and analyzed to determine if the program covered the ISTE National Education Technology Standards. The results of this study showed that technology is integrated throughout the program and is guided by the TPACK theoretical model. While methods of technology integration varied as to
individual faculty, the underlying conclusion of the data is that the Teacher Preparation Program uses the TPACK framework and the ISTE NETS-T to prepare their pre-service teachers to effectively integrate and use technology. The findings of this study add to the research institutions can use to promote technology literacy in pre-service teachers.
DEDICATION

This paper is dedicated to Dr. Lenor Foster. I want to thank Dr. Lenor Foster for all that he did for me. I would not have gotten to where I am at without his guidance. Dr. Foster helped to set me on the path that I am on today. He was a demanding teacher who pushed his students to improve. He was also a friend who loved life as much as he loved lying in bed reading with a bottle of Merlot and *The Chronicle* from cover to cover. He will be sorely missed.
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CHAPTER 1 INTRODUCTION

Studies on the benefits of technology in education are so numerous that researchers are currently producing meta-studies on the subject. A literature search on the benefits of technology in education produced meta-studies published from 1997 through 2006 (Kay, 2006; Kulik, 1994; Sivin-Kachala & Bialo, 2000; Waxman, H. C., Lin, M.F., and Michko, G., 2003). These studies show broad results, including evidence that computers have had small or negligible effects on student learning as well as evidence that computers have had a positive effect on achievement scores, attitudes toward learning, and deeper learning of concepts (Kay, 2006). Despite studies providing opposite results on the benefits of technology, federal policy and legislation currently dictate the need for technology literacy and integration in education.

Over the last thirty years, policy makers and education reformers have expressed the need for integrating technology into K-12 education beginning with the report, A Nation at Risk, and including the most current revision of the Elementary and Secondary Education Act (Culp, Honey, & Mandinach, 2005; Ferending, 2003; Gardner, 1983). Culp et al. reviewed documents pertaining to educational technology produced from 1983 through 2003; these included two national technology plans, congressional reports on educational technology, reports from presidential commissions on educational technology, and reports from professional and governmental organizations in the area of educational technology. A review of these documents revealed that each contained a rationalization for educational technology. These rationalizations were categorized into three themes: technology used as a tool for addressing the challenges in teaching, technology as a change agent, and technology as a driving force to create economic competitiveness (Culp et al., 2005).
The Elementary and Secondary Education Act (ESEA) was last reauthorized as the No Child Left Behind Act (NCLB). The NCLB Act was passed in 2001 to “close the achievement gap with accountability, flexibility, and choice, so that no child is left behind” (No Child Left Behind Act (NCLB), 2008, p. 1425). The goal of NCLB was to reform educational programs in order to promote accountability, provide more choices for parents, increase local and state control of funding, and to focus on scientific research based methods (NCLB, 2008). In the efforts to reform education the NCLB Act also emphasized technology literacy and integration in the classroom.

Currently the National Council for Accreditation of Teacher Education (NCATE) recognizes technology standards from four professional organizations: International Technology Education Association, Council on Technology Teacher Education, International Society for Technology in Education (ISTE), and the Association for Educational Communications and Technology. However, for pre-service teacher preparation, the ISTE and the National Education Technology Standards (NETS-T) for teachers (see Appendix E) are recommended (National Council for Accreditation of Teacher Education (NCATE), 2005). In order to ensure that the technology standards are the same for the preparation of all pre-service teachers, NCATE and ISTE have combined their standards (National Council for Accreditation of Teacher Education (NCATE), 2000). These combined efforts were encouraged by the NCLB Act to ensure common technology standards for all teachers (Roblyer & Edwards, 2000). NCLB encouraged technology use and integration through Preparing Tomorrow’s Teachers for Technology (PT3) grants as well as through the recognition of the ISTE technology standards. The requirements of NCLB state, “Each student is to be technologically literate by eighth grade. Students are considered technology literate by meeting specific technology literacy standards developed by

Under the current administration, the ESEA is in the process of being reauthorized. A Blueprint for Reform: The Reauthorization of the Elementary and Secondary Education Act (2010) is the U.S. Department of Education’s vision for the reauthorization of the ESEA. The proposed reauthorization will attempt to incorporate the existing ideas and framework of the American Recovery and Reinvestment Act of 2009 (U.S. Department of Education, 2010). Though the exact details of the reauthorization have not been released, the Blueprint for Reform states that the reauthorization will ensure that students receive a complete education including literacy in technology which will include improved standards to ensure college readiness (U.S. Department of Education, 2010).

Policies developed by current legislation and accreditation organizations dictate that pre-service teachers need to be technology literate (Cradler, Freeman, Cradler, & McNabb, 2002; Strudler, McKinney, Jones, Quinn, 1999; Willis & Mehlinger, 1996). Standards developed by ISTE dictate the requirements for pre-service teachers to be considered technology literate. However, there is no conclusive research on the most effective method of providing technology literacy skills. Therefore, this study seeks to find exemplary teacher preparation programs that are succeeding in preparing pre-service teachers to effectively integrate and use technology in order to develop a model that other institutions can use as a blueprint for restructuring their programs.
Purpose of Study

The purpose of this study is to examine how an exemplary teacher education program prepares pre-service teachers to be technology literate upon graduation. The *Educating Teachers Report: Educating School Teachers* (Levine, 2006) identified the top teacher preparation programs in the United States. Of these exemplary institutions, one Teacher Preparation Program was noted as an exemplary institution in the preparation of pre-service teachers in technology literacy. This study reviewed this program in order to determine how this institution produces technology literate pre-service teachers.

Significance of the Study

Research shows that teacher education programs are doing a better job of integrating technology. Best practice research (Dawson & Nonis, 2000; Falba, Strudler, Bean, Dixon, Markos, & Zehm, 1999; O’Bannon, Matthew, & Thomas, 1998; Strudler & Grove, 2002; Thomas, 1998), professional organization recommendations (International Society for Technology in Education, 2008; National Council for Accreditation of Teacher Education (NCATE), 2008), and federal legislation (NCLB, 2001) have led to a high percentage of teacher education programs that integrate technology in methods and content coursework and in teaching experiences. The most recent study conducted that offers current statistics on technology in teacher education programs, *Educational Technology in Teacher Education Programs for Initial Licensure*, was conducted at the request of the Office of Educational Technology and the U.S. Department of Education by Kleiner, Thomas and Lewis (2007). One focus of this study was how pre-service teachers were prepared to integrate technology in their classrooms. A survey using the National Center for Educational Statistics (NCES) and the Postsecondary Education Quick Information System (PEQUIS) surveyed 2,512 institutions throughout the United States
that offered pre-service teacher education programs with a response rate of ninety-five percent (Kleiner et al.). Results from this study indicated progress has been made in how pre-service teachers are being instructed in the areas of educational technology and technology literacy. Of the institutions studied, ninety-three percent reported teaching educational technology in methods courses and seventy-nine percent reported incorporating technology into practicum and student teaching experiences. Seventy-one percent reported teaching educational technology in content courses and stated their pre-service teacher graduates were able to integrate technology in the classroom. Despite this progress, current research suggests that barriers continue to exist in preparing pre-service teachers to become technology literate (Kleiner et al.).

Most pre-service teacher preparation programs address the technology literacy component through a single technology course (Kleiner et al., 2007) in which pre-service teachers are taught to use technology, but not how to teach with technology (Willis & Mehlinger, 1996, emphasis added). Research suggests that a single technology course does not provide adequate training, modeling, or experience to sufficiently train new teachers in the use of technology for the classroom (Niess, 2001). Instead, research on pre-service preparation points to a need for pre-service training programs to include multiple experiences that are distributed throughout all courses in order to train teachers on the use of technology for both learning and instruction (Falba et al., 1999; O’Bannon et al., 1998). Dawson and Nonis (2000) recommend pre-service programs include technology-based field experiences. Strudler and Grove (2002) state programs should have technology requirements during student teaching.

Teacher education programs are accredited by one of two professional organizations: National Council for Accreditation of Teacher Education (NCATE) or Teacher Education Accreditation Council (TEAC). These accreditation organizations dictate standards of
knowledge that pre-service teachers must acquire before licensure. Even though these standards are clearly stated, each institution determines the ways in which the standards are met. Currently, there are no mandated models for teacher education programs.

The Elementary and Secondary Education Act has set a precedent for the development of highly qualified teachers. In ESEA’s current incarnation as No Child Left Behind, a highly qualified teacher is considered technology literate. According to NCLB, a teacher is considered technology literate if they have mastered the International Society for Technology in Education’s National Educational Technology Standards. As legislators prepare to reauthorize the Elementary and Secondary Education Act, preliminary documentation shows an emphasis on technology will continue to be included. Regardless of which reauthorization is currently in place, it is clear that technology will continue to be an important component in education. To ensure that graduating pre-service teachers are technology literate teacher education programs need effective methods of preparing them to integrate and use technology.

Findings of this study will add to the research on how teacher preparation programs are ensuring technology literacy. In addition, the results of this study will begin research that will assist in developing a model for including technology literacy in a teacher preparation program.

Theoretical Framework

Mishra and Koehler (2006) developed the Technological Pedagogical Content Knowledge (TPACK) model as a framework for incorporating technology instruction into teacher education programs. The model is based on the premise that three types of knowledge are needed to become a successful teacher: technology, pedagogy, and content (Mishra & Koehler, 2006). The TPACK model was based on the concept that teachers need to know more than content and pedagogical knowledge. Teachers need to have “pedagogical techniques that use
technologies in constructive ways to teach content” (Mishra & Koehler, 2006, p. 1029). TPACK builds upon Shulman’s (1986) Pedagogical Content Knowledge (PCK) model with the additional element of technological knowledge. The TPACK model not only looks at how technology, pedagogy and content interact as a process for developing good teaching; it encompasses how these elements react in pairs as well as the interaction of all three elements together (Mishra & Koehler, 2006). The TPACK framework is based on the idea that effective technology integration occurs from the elements of knowledge in isolation (Technological Knowledge, Pedagogical Knowledge, and Content Knowledge), in pairs (Technological Pedagogical Knowledge, and Technology Content Knowledge), and as all three elements together (Technological Pedagogical Content Knowledge) (Mishra & Koehler, 2006).

Figure 1. The Technological Pedagogical Content Knowledge Framework (Koehler, 2011)
The Literature

The review of literature examines how pre-service teacher preparation programs are preparing graduates to successfully integrate technology. Developed by Mishra & Koehler in (2006), the purpose of the TPACK framework was to guide teacher education in a new direction. The TPACK framework was developed for teacher preparation programs to use when creating new curricula that incorporate technology and pedagogy within content areas of knowledge throughout their programs; it can be used holistically to look at an entire program to understand the necessary components for successfully teaching technology literacy.

The TPACK framework includes three domains of knowledge: technology, pedagogy and content. Mishra and Koehler (2006) discuss the importance of looking at the TPACK framework first as it relates to the relationships of domains of knowledge of Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK), prior to reviewing the entire framework. Research on technology literacy in pre-service preparation will be reviewed in the context of how pre-service teachers are prepared in terms of the knowledge domain pairs.

The first section includes Arthur Shulman’s research on Pedagogical Content Knowledge, the foundation of the TPACK model. The second section of the review focuses on Technological Pedagogical Knowledge (TPK); the knowledge pre-service teachers need to use technology for teaching. This section reviews research on the preparation of teachers to use technology. The third section of the review focuses on Technological Content Knowledge (TCK), the teacher’s ability to understand how technology effects and is affected by the subject content being taught. This section reviews research related to the timing of technology instruction as part of program preparation (i.e., single course, whole program integration, within
field experiences). This section also reviews technology literacy standards and program accreditation. The fourth section of the review looks at the TPACK framework as a whole; it reviews related research and discuss the framework. Finally, the review will examine exemplary teacher education programs including the program that will be used for this study.

**Overview of Research Methods**

This study used a descriptive case study design to take an in-depth examination at how an exemplary teacher education program teaches technology literacy. The descriptive case study design was chosen because this design is useful for capturing a detailed account of a phenomenon. A descriptive case study design was also chosen because the study was not guided by a hypothesis and a descriptive case study design is useful when researching areas in education that have little prior research (Merriam, 1998).

**Research questions**

This study will be guided by the following questions:

1. How does the institution’s teacher preparation program ensure that pre-service teachers are technologically literate?
2. How does the institution evaluate its pre-service teachers’ to ensure that they have met the technology literacy standards?
3. How does the institution evaluate their teacher preparation programs to ensure that pre-service teachers are technology proficient?
Sample

The *Educating Teachers Report: Education School Teachers* (Levine, 2006) is a national study of all teacher preparation programs in the United States. This report examines how teacher preparation programs are currently preparing pre-service teachers and highlighted the top exemplary teacher preparation programs in the nation. The *Educating Teacher Report* cited three pre-service preparation programs as meeting the standards of nine criteria [purpose, curricular coherence, curricular balance, faculty composition, research, finances, admissions, graduation and degree standards, and assessment] (Levine, 2006). The institution selected for this study is the Middle America University (MAU) Teacher Preparation Program (Program). The MAU Program is known for its five-year teacher education program that allows prospective teachers the opportunity to obtain their bachelors and master’s degree. The MAU Teacher Preparation Program was selected for this case study due to its longstanding history as an exemplary program in both teacher preparation and technology literacy (Mergendoller, Johnsten, Rockman, & Willis, 1994; Office of Technology Assessment, 1995; Strudler & Wetzel, 1999).

Case study data

Data collection for the study used a variety of techniques including interviews, observations, and document analysis. The interviewees consisted of the Director of Teacher Preparation Program, faculty members, and graduate teaching assistants. Observations for the study were conducted in the institution’s teacher preparation courses using a specific set of protocols recommended by the International Society for Technology in Education (ISTE, 2003).

Finally, a document analysis of course syllabi and course handouts was conducted. The analysis of these documents was used to corroborate and augment evidence from other sources (Yin, 2009).
Assumptions

For the purpose of this study, the following assumptions are applicable:

1. The MAU recognized in the Educating School Teachers report is an exemplary institution whose Teacher Preparation Program should be modeled to prepare teachers for technology literacy.

2. The MAU Teacher Preparation Program is not only an exemplary teacher education program, but also produces pre-service teachers who are technology literate.

Data analysis

A variety of data analysis methods were used for this descriptive case study. The data were gathered from interviews, observations, and document analysis. The data collection includes an interview of Directors of the Teacher Preparation Program, faculty members and graduate teaching assistants of the courses to be observed. Information from the interview with the Director was used to determine which courses would become part of the study. Once the courses had been determined, observations and interviews with the instructors were scheduled. Finally, documentation was requested consisting of course syllabi, accreditation documents, and student exit exams. Access to accreditation documents and student exit exams was denied. The documents analyzed were course syllabi and class handouts. Data were analyzed in order to determine themes and categories using the constant comparative method and pattern matching.

Limitations

The research is focused on an exemplary pre-service preparation program cited in the Educating School Teachers report (Levine, 2006). The pre-service preparation program selected as the subject for this study is the MAU Teacher Preparation Program. A second limitation is a
lack of literature on preparing teachers to use technology within the classroom. A literature review revealed little current research and statistics on technology in pre-service teacher preparation programs. The most current statistics found were published in 2007; however most research and statistics were gathered during the late 1990’s through 2006.
Chapter 2 Review of Literature

This review of literature is designed to provide a knowledge base of the practice of technology integration in K-12 education. This is accomplished through the analysis of past and current research in the field of educational technology and technology integration. The review is guided through the lens of the Technological Pedagogical Content Knowledge (TPACK) framework.

In 2006, Mishra and Koehler published *Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge*, which details a conceptual model for training teachers in technology integration. The TPACK framework was designed to look beyond the individual domains of knowledge: Technology Knowledge, Pedagogy Knowledge, and Content Knowledge. Instead the TPACK framework takes the interactions of each domain pair into consideration, particularly Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), and Technological Content Knowledge (TCK). Each of these domain pairs is described in detail below.

The literature review consists of research related to the domain pairs of knowledge recognized in the TPACK framework regarding research on pre-service teachers’ ability to use and integrate technology in the classroom. The first domain pair is the Pedagogical Content Knowledge in a review of the work of Arthur Shulman. The second domain pair reviewed is the Technological Pedagogical Knowledge domain. This domain focuses on the methods of training pre-service teachers in technology integration. The next domain pair reviewed is the Technological Content Knowledge domain. This domain focuses on technology content,
accreditation, and standards. Finally, the research related to the TPACK framework is reviewed.

**Pedagogical Content Knowledge**

Historically, many teacher preparation programs follow Shulman’s (1986) Pedagogical Content Knowledge model (PCK), which states teacher preparation programs, should not teach pedagogy and content as separate areas of emphasis. Shulman’s (1986) research on teacher education found that pre-service teacher education programs tended to focus on specific categories of knowledge. According to Shulman, these categories of knowledge can be placed in two domains: content knowledge (i.e., subject matter to be taught) and pedagogical knowledge (i.e., practices or skills of teaching). Shulman (1986) stated that programs should focus on combining these two areas so that pre-service teachers learn both content and pedagogy (e.g., skills, strategies, knowledge acquisition).

Shulman believed that the focus of knowledge taught during teacher preparation could be described as a pendulum where one side focused on content knowledge and the other focused on pedagogical knowledge. The content domain of knowledge is the information a teacher needs to know about the subject matter that will be taught. Content knowledge is more than knowing the concepts particular to a specific subject. The pedagogical domain of knowledge is information about the skills, strategies, and methods of teaching, as well as the understanding of the sequence in which the content should be taught. Pedagogical knowledge also includes the evaluation of student learning as well as classroom management. Shulman (1986) stated that teacher preparation focuses on the paradigms of knowledge on either end of the pendulum leaving a “missing paradigm.” Teacher education must not just teach each of these knowledge domains in isolation, instead, teachers need to have a knowledge base that is a blend of pedagogy and...
content (Shulman, 1986). Shulman’s PCK model does not address technology in teacher preparation programs.

Due to the prevalence and use of technology in education, it is necessary to include a third domain of knowledge, technology. The continuous, rapid changes in the technology domain of knowledge make technology difficult to define. Technology is broad in scope and ranges from dry erase boards to computers. The inclusion of the technology domain of knowledge for pre-service teachers is not a new concept. Several researchers reviewing preparation of pre-service teachers have noted the relationship among technology, pedagogy, and content as the extension of Shulman’s model (Hughes, 2004; Keating & Evans, 2001; McCrory; 2004; Niess, 2005; Pierson, 2001).

**Technological Pedagogical Knowledge**

The domain of Technological Pedagogical Knowledge (TPK) refers to the ability to use technology in an educational setting. TPK is the understanding of how technology affects both teaching and learning. TPK is also knowledge of the various technological tools and resources that are available. A review of the literature of pre-service teachers’ TPK includes research related to how institutions are preparing pre-service teachers to effectively use technology in the classroom.

Research addressing the need for colleges of education to prepare pre-service teachers to use technology has existed for more than a decade. The research states that most pre-service teachers did not know how to effectively use technology in the classroom (Office of Technology Assessment [OTA], 1995; Willis & Mehlinger, 1996). The first report given by the Office of Technology Assessment (1995) stated, “seldom are students asked to create lessons using technologies or practice teaching with technological tools” (p.165). In 1997, NCATE found that
most institutions were not preparing pre-service teachers to use technology. *The National Technology Plan*, developed by the U.S. Department of Education, stated new teachers are not being prepared to effectively use technology in the classroom (Riley, Holleman, & Roberts, 2000). *The National Technology Plan* (Riley, et al., 2000) states the need for increased preparation for pre-service teachers based on the fact that they receive approximately twelve hours of computer literacy training (The Milken Exchange, 1999) and that upon graduation, less than fifty percent of pre-service teachers are prepared to teach with technology (CEO Forum on Education and Technology, 2000). The *National Technology Plan* addresses these issues through the use of benchmarks for teacher preparation programs and through the use of Preparing Tomorrow’s Teachers to Use Technology (PT3) grants (Riley et al., 2000).

The *Educational Technology in Teacher Education Programs for Initial Licensure* report (Kleiner et al., 2007) found that even though the majority of institutions surveyed reported success in technology preparation and integration, both faculty and institutional barriers in integrating technology were discovered. Barriers to integrating technology reported by faculty included lack of time, insufficient technology training, or lack of interest in using technology. The four-year institutions used in this study reported significant barriers to technology integration both in course work and in the pre-service teacher’s field experiences. Institutions reported several reasons that barriers to technology integration in the classroom existed: seventy-four percent reported opposing priorities in the classroom; seventy-three percent reported that there was no technology infrastructure available (classrooms were not wired or set up to use technology); sixty-four percent reported a lack of technology training for the professor; sixty-two percent listed time constraints; and fifty-three percent stated an unwillingness on the part of supervising teachers (Kleiner et al., 2007, pg. 37).
Analysis of this study shows that there is a discrepancy between the results. One set of results show that pre-service teachers are being exposed to technology integrated in their pre-service program and that their professors have reported that they have the skills necessary to successfully integrate technology in the classroom. Another set of results produced by this study show that there are significant barriers to the integration of technology in the pre-service program by professors and within the institutions themselves (Kleiner et al., 2007). If results of the study report that pre-service teachers are graduating with the ability to integrate technology, yet it also states that there are barriers to technology integration, how well prepared are pre-service teachers?

It is probable that despite the increase in technology training there is a disconnect between technology training in pre-service teaching preparation and actual ability to integrate technology in K-12 education. One reason for this disconnect is that teacher training tends to be technocentric, meaning that the focus of the training is on using specific software, developing websites, and management tools (Harris, Mishra, & Koehler, 2009; McCormic & Scrimshaw, 2001). Pre-service teachers are being exposed to various technology tools and provided with opportunities to practice using these tools, however exposure to technology tools does not ensure that pre-service teachers are capable of technology integration (So & Kim, 2009). Another reason for this disconnect is that institutions have moved from focusing primarily on the domain of technology knowledge and have transitioned their focus towards the domain of Technology Pedagogical Knowledge. However, institutions have not fully integrated the entire TPACK framework by combining the domain of Technology Pedagogical Knowledge with Technology Content Knowledge.
Technological Content Knowledge

The domain of Technology Content Knowledge (TCK) is an understanding of the influence of interaction between technology and specific content subject areas (e.g., English, math, science, etc.). Knowledge of this domain includes the acknowledgement that technology can both drive and affect content as well as the understanding that the type of content taught influences how the technology is used. While researchers have studied Technology Pedagogical Content Knowledge (TPCK) in specific content subjects (American Association of Colleges for Teacher Education (AACET), 2008), the focus of this review of literature is how pre-service teachers acquire TCK. The first part of this review focuses on the method of technology knowledge acquisition. The second part of this review focuses on the TCK as required by institutional accreditation agencies and technology literacy standards.

The majority of pre-service teacher preparation programs have addressed the technology literacy component through a single technology course (Kleiner et al., 2007). The stand-alone computer course is the earliest technology-training model in teacher education (Wang & Chen, 2006) in which students take a single technology course as part of their program. During this course, pre-service teachers are taught to use technology, but not how to teach with technology (Willis & Mehlinger, 1996). Research suggests that a single technology course does not provide adequate training, modeling, or experience to sufficiently train new teachers in the use of technology for the classroom (Niess, 2001).

There is a growing body of research that moves away from the stand-alone model and towards a technology integration model. Research has shown that the inability for most first-year teachers to effectively use or integrate technology into the classroom can be attributed to a lack of technology modeling and use in pre-service programs, (Cradler et al., 2002; Strudler et
al., 1999; Willis & Mehlinger, 1996). Instead, research has shown that an integration model has better success in preparing teachers to integrate and use technology (Haplin, 1999).

There have been several studies on pre-service preparation that point to a need for pre-service training programs to include multiple experiences that are distributed throughout all courses in order to train teachers on the use of technology for both learning and instruction (Falba et al., 1999; O’Bannon et al., 1998). In the study, Effects of an Educational Computing Course on Preservice and Inservice Teachers, Yildirim (2000) recommends teacher education programs develop a curriculum for technology training that includes both increased computer literacy courses and faculty that demonstrate the use of technology in their teaching. Dawson and Nonis (2000) recommend pre-service programs include technology-based field experiences. Strudler and Grove (2002) state that pre-service teacher preparation programs should have technology requirements during student teaching. One solution is to integrate technology throughout all core courses as well as in the student teaching internship (Dawson & Nonis, 2000; Levin, 1994; Niess, 2001; Wetzel, 1993a, 1993b).

A review of literature on strategies for incorporating technology in pre-service education examined various methods of technology integration into pre-service programs blending combinations of technology skills courses, technology integration throughout entire programs, technology integration into field experiences, and technology project based courses (Gronseth, Brush, Ottenbreit-Leftwich, Strycker, Abaci, Easterling, Roman, Shin, & van Leusen, 2010). Results of the study by Gronseth et al, indicate that most teacher preparation programs provide general technology skills to support instruction (Technological Pedagogical Knowledge) rather than providing authentic technology experiences where pre-service teachers can gain insight into the interactions between technology and content (Technological Content Knowledge) (Gronseth
et al., 2010). There is no conclusive evidence as to which technology integration strategies work best (Kay, 2006). Until an effective model for technology integration in pre-service education has been determined, institutions must use accreditation and technology literacy standards as a guide to determine the content pre-service teachers need to know in terms of how to integrate technology.

**Accreditation**

There are two different teacher education accreditation organizations, the National Council for Accreditation of Teacher Education (NCATE) and the Teacher Education Accreditation Council (TEAC). The MAU Teacher Preparation Program is accredited by TEAC. The technology literacy standards differ between the two-accreditation agencies, thus an explanation of the technology literacy standards for each organization is warranted.

*National Council for Accreditation of Teacher Education*

NCATE was founded in 1954, replacing the American Association of Colleges for Teacher Education as the agency responsible for accreditation in teacher education (NCATE, 2008). NCATE accredits each institution or entity that is responsible for the preparation of teachers. In order to be accredited, NCATE (2008) mandates that each institution must meet the following six standards:

1. candidate knowledge, skills, and professional dispositions
2. assessment system and unit evaluation
3. field experiences and clinical practice
4. diversity
5. faculty qualifications, performance, and development
6. unit governance and resources
Standard 6e, unit resources including technology, details the level of technology literacy and integration for institutions. According to the Professional Standards Accreditation of Teacher Preparation Institutions, newly graduated teachers should “be able to integrate technology into instruction effectively” (NCATE, 2008, p. 9). In terms of fulfilling this standard, NCATE recommends that institutions use the ISTE standards for the preparation of pre-service teachers (NCATE, 2005).

*Teacher Education Accreditation Council*

The TEAC was founded in 1997, and along with NCATE, is a recognized accreditation organization for teacher education programs by the Council for Higher Education Accreditation and the U.S. Department of Education. TEAC does not use the ISTE standards for technology literacy as a part of their accreditation standards. Teacher preparation programs accredited by TEAC must ensure that pre-service teachers know how to use productivity enhancement software and technology to enhance student learning (Teacher Education Accreditation Council (TEAC), 2006). As a part of the TEAC accreditation process, institutions must provide evidence that pre-service teachers have acquired basic proficiency for productivity technology such as “grade book computer programs, databases, spreadsheets, word processors, electronic mail, bulletin boards and networked conferences, Internet access, interactive videodiscs, and instructional software, all of which are now part of the modern teacher’s repertoire” (TEAC, 2006, p. 1).

*Technology Literacy Standards*

NCATE currently recognizes technology standards from four professional organizations: International Technology Education Association, Council on Technology Teacher Education, International Society for Technology in Education, and the Association for Educational
Communications and Technology. However, for pre-service teacher preparation the ISTE NETS-T for Teachers (Appendix E) is recommended (NCATE, 2005). In order to ensure that the technology standards are the same for the preparation of all pre-service teachers, NCATE and ISTE have combined their standards (NCATE, 2000). These combined efforts were encouraged by the same legislation to ensure common technology standards for all teachers (Roblyer & Edwards, 2000). The NCLB Act of 2001 states that “NCLB requires each student to be technologically literate by eighth grade by meeting specific technology literacy standards developed by the U.S. Department of Education and the International Society for Technology in Education” (Learning Point Associates, 2007, p. 4). The ISTE NETS-T for teachers is recommended by both NCATE and NCLB, thus the purpose of this study was to evaluate exemplary pre-service teacher preparation programs to determine how they are ensuring their students meet these standards.

TPACK Related Research

In 2001, research began to build on Shulman’s PCK model and stated that in order to achieve effective technology integration, a connection needed to occur between technological, pedagogical, and content knowledge (Keating & Evans, 2001; Pierson, 2001). In Pierson’s (2001) multi-case study, she found that disparities existed between definitions of technology integration; further, classroom technology was dependent upon the teacher’s definition of technology integration, technology knowledge, and personal learning preferences.

In their study of pre-service teachers, Keating and Evans (2001) determined that a missing component in teacher preparation is technology use in the classroom. This study looked at the relationship between learning theories, strategies, and technology and called for explicit modeling and teaching with technology. They suggested a need for a framework that
incorporated technology, pedagogy, and content that would help teacher preparation programs teach how technology can be used to teach content.

This research by Keating and Evans (2001) led to future research on the relationship of technology, pedagogy and content. In her technology-learning principals for pre-service teachers, Hughes (2004) discusses the need for technology integration to rely on pedagogical content knowledge. McCrory (2004) builds upon Shulman’s (1986) work stating that the new missing paradigm is technology knowledge, and that the ability to effectively use technology to teach occurs at the intersection of content knowledge, pedagogical knowledge, and technology knowledge.

Additional research into the relationship between technology, pedagogy, and content describes the TPACK framework using different terminology. Margerum-Leys and Marx (2002) studied the use of technology and how it applies to pedagogy in their PCK of technology model. In a qualitative study of elementary teacher computer use, Franklin (2004) determined that the key to technology integration is through the electronic PCK model. Angeli and Valanides (2005) developed an instructional systems design model for the training of pre-service teachers that would encourage information and communication technology (ICT) use. This research leads to teacher education courses for the purpose of developing ICT related PCK (Angeli & Valanides, 2005). In her research of pre-service science and math teachers, Niess (2005) studied the effects of technology integration within the teacher preparation program, which developed pre-service teachers’ technology-enhanced PCK. In 2006, Mishra and Koehler published *Technological Pedagogical Content Knowledge: A New Framework for Teacher Knowledge* in which they describe their technological pedagogical content knowledge (TPACK) framework as the knowledge that teachers need for effective technology integration.
Mishra and Koehler state that it is important to look at how technology effects and is affected by pedagogy and content (2006). In their research they highlight the necessity of viewing the knowledge domains of technology, pedagogy and content as pairs. In order to determine effective technology integration the interrelationships of Technological Pedagogical Knowledge and Technological Content Knowledge must first be reviewed. Once technology integration has been viewed as domain pairs it is essential to look at technology integration using the TPACK framework.

TPACK, previously known as TPCK, (Thompson & Mishra, 2007) emerged from the development of Mishra and Koehler’s (2006) learning by design approach to educational technology. TPACK was developed to be a model for technology integration in pre-service teacher education programs. The model is based on the premise that three types of knowledge are needed to become a successful teacher: technology, pedagogy, and content (Mishra & Koehler, 2006). Through their research Mishra and Koehler (2006) discovered the relationship between technology, pedagogy, and content (Koehler, Mishra, Hershey, & Peruski, 2004) and developed their initial model of how the interaction of these are used in their learning by design model for technology integration (Koehler et al., 2004). The TPACK model was based on the theory that teachers need to know more than concept and pedagogical knowledge. Teachers need “pedagogical techniques that use technologies in constructive ways to teach content” (Koehler et al., 2004, p. 1029). The TPACK framework builds upon Shulman’s (1986) PCK model with the added domain of technological knowledge. The TPACK model not only looks at how technology, pedagogy and content interact as a process for developing good teaching; it encompasses how these domains react in pairs as well as the interaction of all three domains together (Mishra & Koehler, 2006).
In 2006, Mishra and Koehler detailed the TPACK framework as a model for the body of knowledge that teachers need to integrate technology in the classroom. TPACK can also be used as a framework for assessing a teacher education program’s ability to teach the technology concepts necessary to achieve technology literacy. An assessment of teacher education programs could use the TPACK model to study how the program is teaching both Technological Content Knowledge and Technological Pedagogical Knowledge. In 2009, Schmidt et al. began using the TPACK framework to guide a longitudinal study on pre-service teacher knowledge of technology and integration. This study obtained its initial data through the use of a survey instrument that gauges pre-service teacher knowledge of the different knowledge domains in isolation, in pairs, and as a whole, with the goal that the instrument could be used as an assessment tool for teacher preparation programs in the development of TPACK in their pre-service program.

Exemplary Teacher Preparation Programs

Teacher preparation programs have recognized the need for technology training as part of pre-service preparation. The traditional method of training addresses the integration of technology education through a single technology course. However, recent research suggests that technology should be modeled and taught throughout the entire program rather than through a single course.

Moursund and Bielefeldt (1999) recommend finding teacher preparation programs that are successful in producing teachers with the ability to effectively use and integrate technology in the classroom. These programs should then be used as models for other university programs. In his national study of colleges of education Levine (2006) highlighted four exemplary teacher preparation programs, three of which are pre-service preparation programs. If these teacher
education programs are to be modeled at other institutions, it is necessary to discover the
technology literacy standards they utilize to hold their graduates accountable.

As mentioned previously, teacher education programs are generally accredited by
NCATE or TEAC. Both accreditation agencies have standards related to technology literacy. It
is also important to look at the technology standards recommended through NCLB. The U.S.
Department of Education recommends teachers meet the criteria of the ISTE NETS-T for
teachers. Knowledge of the technology literacy standards from NCATE, TEAC, and ISTE
NETS-T was invaluable in determining how these pre-service programs are ensuring their
graduates are technology literate and have the ability to integrate technology in the classroom.

Model Teacher Preparation Programs

Educating School Teachers (Levine, 2006) is the second report in a four-part series. This
report takes a series of studies along with case studies of colleges of education to look at pre-
service teacher education programs. This report highlights four exemplary teacher education
programs: Alverno College, Emporia State University, Stanford University, and University of
Virginia.

Levine (2006) used a series of six surveys to develop his report. The dean survey was
circulated to every dean, department chair, and director of all U.S. colleges of education. The
survey explored the college’s demographic information as well as “personal experiences,
attitudes, and values” (Levine, 2006, p.116). The faculty survey looked at the “experiences,
attitudes, and values” regarding their college by taking a sample of 5,486 education faculty
members (Levine, 2006). The alumni survey was distributed to a representative sample of
15,468 alumni and asked respondents about their careers and their college experiences (Levine,
2006). The principal survey questioned 1,800 principals about their “own education, the
education of the people they hire, and their attitudes and values regarding education schools” (Levine, 2006). The demographic study was performed by using data from the dean survey and NCATE (Levine, 2006). Data from the CIRP Freshman Survey from the Higher Education Research Institute located at the University of California, Los Angeles and from the study of Teacher Characteristics and Student Achievement by the Northwest Evaluation Association were also used in the report (Levine, 2006).

In addition to survey data, the *Educating School Teachers* report also included data gleaned from case studies from twenty-eight different colleges of education. Information from each college was gathered regarding the “history, mission, programs, admissions, graduation requirements, plans, and funding” (Levine, 2006). The case studies were selected to be representative colleges in the U.S. and were provided anonymity except for those that were listed as exemplary programs.

As a part of the *Educating School Teachers* report Levine offered six recommendations to improve teacher education. According to Levine (2006) universities need to:

1) Transform education schools from ivory towers into professional schools focused on school practice.

2) Focus on student achievement as the primary measure of the success of teacher education programs.

3) Make five-year teacher education programs the norm.

4) Establish effective mechanisms for teacher education quality control.

5) Suspend failing teacher education programs, strengthen promising ones, and expand excellent programs.
6) Create incentives for outstanding students and those interested in career changes to enter teacher education at doctoral universities.

Alverno College is a Catholic women’s college located in Milwaukee, Wisconsin. Although Alverno is a small college, over one-third of its graduates are in programs for teachers (Levine, 2006). Each pre-service teacher must show competence in the areas of “communication, analysis, problem solving, valuing in decision making, social interaction, developing a global perspective, effective citizenship, and aesthetic engagement” (Levine, 2006).

Emporia State University in Emporia, Kansas, offers eleven undergraduate and thirteen graduate education programs and typically educates over 1,100 undergraduate pre-service teachers annually (Levine, 2006). Pre-service teacher preparation is composed of three elements; the first element is a three-tiered curriculum that includes courses on core academic subjects along with the courses “Professional Competencies of Teachers” and “Foundations of Curriculum Development”; the second element is clinical experience that places students in internships within districts that allow schools to hire successful interns; the third element is a partnership between local public schools and arts and sciences faculty (Levine, 2006). These partnerships allow both college and K-12 faculty to feel invested and connected to the teachers being educated within the program.

Stanford University has taken a different approach to teacher education. The Stanford Teacher Education Program (STEP) is a one-year masters program that combines a yearlong classroom experience with 45 units of coursework (Levine, 2006). This program is also unique in that an electronic portfolio replaced the thesis requirement for graduation. This electronic portfolio “documents how the student has met the required standards, showing competence in
addressing the needs of all students, classroom management, pedagogical content knowledge, curriculum design, assessment, and professional development” (Levine, 2006).

The University of Virginia differs from other schools in that they offer a five-year teacher education program. This program is characterized by its field experiences where students typically spend up to 90 hours in the field by the fourth year of coursework (Levine, 2006). In the students’ fifth year they work towards their master’s degree while performing a semester of student teaching followed by a semester that includes a capstone course and work on a research project (Levine, 2006).

Levine (2006) proposed nine criteria for excellence that were applied to teacher education programs: purpose, curricular coherence, curricular balance, faculty composition, research, finances, admissions, graduation and degree standards, and assessment. As a part of the curricular coherence criteria, Levine (2006) states that all four institutions are “preparing students with knowledge of pedagogy, child development, and the content field in which they will teach.” Levine (2006) briefly details how each of the four universities incorporate technology as part of their curriculum; however, he does not go into detail and none of the criteria specifically detail the technology proficiency of the students. This indicates that further research on how these institutions are preparing their pre-service teachers to be technology literate is warranted. Moursund and Bielefeltdt (1999) recommended that examples of effective technology instruction be disseminated throughout the education community as a model. The study examined the MAU Teacher Preparation Program, which has been recognized as an exemplary teacher preparation programs according to the Educating Teachers Report.
Summary

Not only is technology becoming more prevalent in the educational system, the Elementary and Secondary Education Act mandates its integration and implementation. This literature review provided research on technology in pre-service preparation through the lens of the TPACK framework. Research on technology in education has built upon the research of the Pedagogical Content Knowledge and the Technological Pedagogical Knowledge. The research shows that there has been an increase in technology integration and training in pre-service preparation programs. However, research also shows that despite this increase in technology use, significant barriers continue to impede technology integration and use within pre-service teacher preparation programs. Research on Technological Content Knowledge has indicated that a single technology course is not sufficient to train future teachers in technology integration. Instead research suggests that technology should be integrated throughout the entire teacher preparation program and included within the practical experience. However, research has not indicated the best method for providing technological integration throughout a program. The TPACK framework can be used as a lens through which to view how an exemplary teacher preparation program prepares their pre-service teachers to be technology literate. Research suggests that exemplary teacher preparation programs should be analyzed in order to determine how they prepare their pre-service teachers. The MAU Teacher Preparation Program has been recognized as having one of the top teacher preparation programs in the nation. In order to better understand how this program prepares its pre-service teachers, the program was studied using the TPACK framework as a guide.
Chapter 3 Methods

The purpose of this study was to examine how an exemplary teacher education program as described by Levine (2006) in *Educating Teachers* prepares pre-service teachers to be technology literate upon licensure. Qualitative research, generally associated with the social sciences, examines individual and social settings to better understand perceived phenomena (Berg, 1998). The traditional methods of data collection in qualitative research are observations, interviews, and document analysis (Creswell, 2003). Creswell denotes five methods for conducting qualitative research: biography, phenomenology, grounded theory, ethnography and case study. A qualitative approach examines the meaning of experiences through the perceptions and observations of individual or groups (Creswell, 2003). A case study design is suitable when studying an event or phenomenon to gain a holistic view of real-life events in a natural setting (Yin, 2009). A case study design was used to provide an in-depth examination of how one Universities’ teacher education program prepares its novice teachers to be technology literate. This chapter describes the design of the study. The following sections discuss case study methodology along with the selection of the case and participants. In addition, the research design is presented including procedures, instrumentation, and data collection and analysis.

*Case Study Methodology*

Case study research has become one of the most prominent methods of qualitative research and one of many approaches today’s researchers use to expand research in the field of education. One of the many definitions of case study methodology is research of a “bounded system” (by time and place) or “case” (a program, event, or individual) over time through detailed, in-depth data collection involving multiple sources of information rich in context.
Another definition (Yin, 2009) describes case study methodology as an “empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used” (Yin, p. 18). Case study methodology is commonly used in the social sciences to gain close insight into a phenomenon.

Yin (2009) described three types of case study research: exploratory, explanatory, and descriptive cases. The three types of case studies are based on the type of research question(s), the extent of control a researcher has over the event and the degree of focus on contemporary events (Yin, 2009). Exploratory case studies focus on the question “what” and are generally used to determine hypotheses or areas for future research (Yin, 2009). Exploratory studies usually take place prior to a more major study to determine research questions and hypothesis (Yin, 2003). Explanatory case studies use the research questions “how” and “why,” particularly when studies are looking at experiences over a period of time (Yin, 2009). Explanatory case studies are used to determine cause-effect relationships in order to explain how the events happened (Yin, 2003). Descriptive case studies ask “who,” “what,” “when,” “why,” and “how” in order to describe an event or phenomenon (Yin, 2003, 2009).

Merriam (1998) details three different types of case study research: descriptive, interpretive, and evaluative. Descriptive case studies provide a detailed account of a phenomenon. This type of study is not guided by a hypothesis and can be useful when researching areas in education that have little prior research (Merriam, 1998). Interpretive case studies are composed of rich, thick descriptions of a phenomenon, and are used to develop, support, or challenge theories and hypotheses made prior to the research (Merriam, 1998). Evaluative case studies involve description, explanation, and judgment of a program. An
evaluative case study is used to develop a better understanding of the dynamics of a program by providing a holistic, rich description of the program.

This case study asked “what” and “how” questions to describe the phenomena of integrating technology literacy into a pre-service teacher education program by asking how pre-service teachers are being prepared, what standards are being met, and what skills are being taught to achieve technology literacy. This study was not be guided by a hypothesis. Instead the study attempted to gain a holistic view of the selected ‘case’ in order to provide a detailed description of how the educational program achieved the afore mentioned phenomena using a descriptive case study methodology.

Case Selection

Creswell (1998) defined a ‘case’ as a program, event, individual, or organization. The case for this study is an institution from Levine’s (2006) Educating Teacher report, which evaluated teacher education programs across the nation. This University has been selected due to the institution’s history as an exemplary teacher preparation program, which integrates technology literacy across the course of studies. The institution is designated in this study as the Middle America University (MAU). Historically the Middle America Teacher Preparation Program has been described as an exemplary teacher preparation program in the area of technology literacy (Mergendoller, Johnsten, Rockman, & Willis, 1994, OTA, 1995, Strudler & Wetzel, 1999). Middle American University, a public institution, was founded over 180 years ago. Eleven schools and a branch campus comprise the MAU system. MAU offers 51 bachelor degrees, 81 masters degrees and 57 doctoral degrees, as well as professional degrees in law and medicine (Rector and Visitors, 2012). The main campus of MAU is residential with a student
population of approximately 24,000. The Carnegie Foundation (2010) lists MAU as a research university with a high level of research activity.

The MAU Teacher Preparation Program is a small program. In 2011 the Program had 145 applications, 73 applicants were sent letters of acceptance, and 43 applicants accepted the offer and began the program (J. Painter, personal communication, 01/31/2012). The Teacher Preparation Program is a 5-year program explained in more detail in Chapter 4. At the time of the study, 34 faculty members served the teacher preparation program, with 11 of those faculty members teaching content methods courses.

Data Collection

Yin (2009) lists six sources of data collection: documentation, archival records, interviews, direct observation, participant observation, and physical artifacts. Merriam (1998) suggests that qualitative research implies data collection using interviews, observations, and document analysis. Yin (2003) states that the principles of data collection are as important as the data collected. These principles are to use multiple data sources, to create a database for the information, and to follow the chain of evidence (Yin, 2003). Data collection for this study used a variety of techniques including interviews, observations, and document analysis.

Interviews served as the first data source for this study. The interviews took place within Johnson Hall at each interviewee’s office. The interviews were based on questions developed from the review of literature the researcher prepared (see Appendix B). Yin (2009) refers to this type of interview as a focused interview. These lasted between forty-five and sixty minutes and consisted of five questions. The researcher used a combination of purposeful and snowball open-ended questions. The purposeful questions were determined from issues raised by the review of literature (Merriam, 1998; Yin, 2009). The intent was to gain insight into the events...
taking place within the teacher preparation program. Requests for interviews and observations were made to the faculty members teaching both Elementary and Secondary content area courses and to the graduate instructors teaching the technology courses. A total of sixteen requests were sent with twelve responses being returned.

To develop a broad understanding of the Teacher Preparation Program, the first participant selected for a formal interview was the Director of the program. The Director was interviewed regarding how technology literacy is taught at MAU and which courses would be best to observe. Based upon the interview with the Director, requests for interviews and observations were made to the professors who taught content area courses and with the graduate instructors who taught the teaching with technology courses.

Observations for this study were conducted in Miller Hall at the MAU Teacher Preparation Program. Yin (2009) lists two types of observations: formal and less formal. The formal observations for this study used a specific set of protocols recommended in the ISTE National Educational Technology Standards for Teachers: Resource for Assessment (2003). The ISTE NETS-T Resource for Assessment manual (International Society for Technology in Education (ISTE), 2003) provides three observation instruments, two of which were used for this study. The first assessment, the Integration of Technology Observation Instrument (Appendix D), was developed as part of the Arizona State University West’s Preparing Tomorrow’s Teachers to Use Technology (PT3) Grant (ISTE, 2003). The second instrument, the Snapshot Assessment Instrument (Appendix E), was used to collect data on technology use in multiple classrooms (ISTE, 2003). These instruments are explained in further detail within the instrumentation section of this chapter.
The last method for collecting data was document analysis. This form of data collection was used to corroborate and augment evidence from other sources (Yin, 2009). Every pre-service program has certain curricular requirements to meet accreditation standards. Data collection for the document analysis included requests for course syllabi and institutional accreditation documentation explaining how the ISTE standards are met. The Director of Teacher Education denied the request for institutional accreditation documentation. The data request for syllabi was made to the 12 participants of the study with 6 syllabi being provided for use in this study.

**Procedures**

Prior to the study, the researcher contacted the Director of Teacher Education for the institution’s Teacher Preparation Program to schedule a date and time for an interview. A brief consent letter was sent to the Director explaining the intended purpose and expected outcomes of the study (see Appendix A). The researcher followed up through emails and phone calls to schedule an appointment for the interview.

During all interviews the researcher asked five purposeful, open-ended questions developed from issues discovered through a careful review of the literature. In addition to the purposeful questions asked during the interview, a snowball questioning technique was used. Snowball questions were not predetermined but occurred during the interview process. In addition to an interview, the Director was asked to identify courses that demonstrate the teaching of technology literacy standards and skills.

A review of the institution’s course catalog shows that the program has technology related coursework as part of the student’s program of study. Course information including the faculty member teaching the course, dates and times was obtained. In addition to the technology
course, the Director was queried during the interview for additional courses throughout the program that promote technology literacy. This query led to the recommendation of the faculty members and graduate instructors to be interviewed and observed.

Before any course observations occurred, permission was obtained from the Program and the instructor of the course. Two types of observation instruments were used: the Integration of Technology Observation Instrument (evidence of technology integration in a course) and the Snapshot Assessment Instrument (evidence of technology use and alignment with technology standards).

The first observation instrument, the Integration of Technology Observation Instrument, was developed at Arizona State University in conjunction with Mike Timms of WestEd as part of the Arizona State University West’s Preparing Tomorrow’s Teachers to Use Technology (PT3) Grant (ISTE, 2003). Permission to use this instrument was given by Dr. Helen Padgett, the project manager for Arizona State University’s PT3 project (personal communication, October 18, 2010). The instrument was designed to be adapted so that portions could be added or deleted as needed. Using this instrument, data were collected at three-minute intervals over the course of a single class (~three hours) to check the use of technology in the classroom. A total of seven different courses were observed using this instrument. Each individual course was observed one time for the entire length of the class. The instrument measures both National Education Technology Standards for teachers (NETS-T) and students (NETS-S). The instrument was used to gain information about access to technology, teachers’ skills, standards addressed, and student learning.

The second instrument utilized, the Snapshot Assessment Instrument, has categories based on the International Society for Technology in Education National Educational
Technology Standards (ISTE NETS) essential conditions so that technology use at a site can be assessed (ISTE, 2003). This instrument was not designed as a complete assessment tool; rather, it should be used to attain quick data in multiple sites. For this study, the instrument was used to look at the program to determine if the program has the necessary elements to implement National Education Standards. The Snapshot Assessment Instrument was intended for administrators, teachers, or technology directors within a school setting. However, this instrument is easily adaptable for use in a university setting since it can be used to look at trends of technology use throughout a program.

The researcher also requested course syllabi for those courses observed. In order to increase reliability, the Syllabi Evaluation Checklist was used to look for data to triangulate data from the interviews and observations. The Checklist was developed at Arizona State University for the purpose of analyzing course syllabi and assessing which National Education Technology Standards a course addresses (e.g., planning and design, learning environments and experiences, teaching, learning, curriculum, and productivity and professional practice) (ISTE, 2003).

Finally, accreditation documentation was requested to review how the College portrays meeting technology standards compared to the data collected. The Director denied the request for accreditation documentation.

Data Management

In order to increase reliability and to ensure that the data collected and analyzed remained focused, a case study protocol and database were used (Yin, 1994). The case study protocol is recommended by Yin (2003) for case studies. A protocol increases reliability by ensuring that the study can be reproduced using the same guidelines and procedures. The protocol for this
case study contained an overview of the project, field procedures, research questions, time schedule, and a plan for analysis and reporting.

A database was created for all evidence collected throughout the study. Evidence included field notes, transcripts of interviews, copies of documents, and observation data. The case study database was saved in both electronic and hard copy form. The hard copy was stored in a locked file cabinet in the researcher’s home office.

An electronic version of the case study database was hosted via a secure online workspace. All data gathered as part of this study were held within the electronic database. This security measure ensured that only the researcher and committee could access or view confidential information. In addition to security, the information in the workspace was backed up daily so information was safe and a document version history was kept.

Data Analysis Procedures

A variety of data analysis methods were used for this descriptive case study. During the first cycle of data analysis, themes and categories were determined using the constant comparative method and pattern matching. Multiple sources of data were triangulated to improve the validity of this study. When using multiple methods of data collection and analysis, triangulation can also strengthen reliability (Merriam, 1998). The three sources of data for this study were interviews, observations, and document analysis. In triangulation, data from multiple sources are corroborated. Triangulation of the data was used to determine if similar patterns were found across the three data sources.

The constant comparison method is a form of data analysis used in descriptive case studies when the researcher is not necessarily trying to develop a theory from the data (Merriam, 1998; Yin, 2003). Using the constant comparative method, categories were first determined
using structural coding. Structural coding is a process used to simultaneously code and categorize data and is often used for analysis of interviews, field notes, and open response surveys (Saldana, 2009). Structural coding for this study used the five interview questions as the initial codes for the data gathered from the interviews and research field notes. Next, the data from observations and documents were coded using the structural codes. Initial, or ‘open’ coding, is often used for interview transcripts to assign codes for organizing, summarizing, or reducing data (Saldana, 2009). The transcripts were reviewed line by line and codes were assigned.

A second cycle of coding was conducted to further organize and analyze the data. The goal of the second cycle of coding was to develop themes based upon the codes determined through the first cycle of coding (Saldana, 2009). The second cycle of coding used theoretical coding in which all of the categories found during the first cycle of coding were systematically linked by the researcher to find central core categories providing the greatest relevant coding (Saldana, 2009). These efforts aided the researcher in identifying emerging themes and patterns from the data. Documents used for document analysis were syllabi and any course documents given out during the time of the observation. The syllabi were analyzed using the Syllabi Evaluation Checklist to determine whether information listed on the syllabi matched NETS-T. Document analysis provided a means of triangulation to confirm evidence of technology integration, technology modeling, and technology use in the classroom. This procedure enabled the researcher to discover how technology literacy and the technology standards are addressed in the teacher preparation program.
Role of the Researcher

In many ways this study has been shaped by my own experiences as a special education teacher. My interest in technology integration guided my Master’s thesis, led to an additional certificate in instructional design, the development of online education, and finally to this study examining one teacher preparation program recognized for the high level of technology literacy of its novice teachers.

As a teacher I saw the limitless potential technology offers in education, especially in my own work in differentiating instruction for students with disabilities. I believe that today’s students are tech savvy individuals who yearn for opportunities to use technology and, when given the chance, can use technology to propel their own learning. Observing the increased motivation to learn among my own students when technology was integrated as a tool convinced me of the value of technology in K-12 education. However, I have also seen how some teachers struggle to integrate and use technology in their classrooms. These very divergent experiences have led me to study pre-service teacher preparation and technology literacy.

The purpose of this study was to look at how an exemplary teacher preparation program prepared its pre-service teachers to be technology literate. A case study methodology was used to guide this research. As the researcher it is my responsibility to interpret the data, and while one aspect of qualitative research is that the researcher invariably affects the research, in the interest of reporting the data in an unbiased way a mixed methods approach to data collection was used to gather both qualitative and quantitative data. I used triangulation to support the findings and to mitigate some of the researcher bias.

Qualitative research is about trustworthiness and the researcher’s ability to demonstrate the strength of study by demonstrating techniques used to insure that the results are credible,
transferable, dependable, and confirmable. This study used a mixed methods approach to data collection. A relationship was found between the quantitative methods of quality and qualitative methods of trustworthiness. This relationship led to the pairing of the following quantitative and qualitative methods:

- Construct validity and confirmability,
- Internal validity and credibility,
- External validity and transferability, and
- Reliability and dependability.

The utilization of these methods by the researcher to improve the quality of this study and to limit researcher bias will be discussed in the data verification section.

**Definition of Terms**

This study stands at the crossroads of quantitative and qualitative research. Quantitative data were gathered using the three instruments discussed above. The qualitative research aspects include the case study design and the interview data. The quantitative terminology is derived from Yin’s (2009) work on the criteria for quality in case study research. The qualitative terminology is derived from Lincoln and Guba’s (1985) work on trustworthiness. The terms are used when appropriate to discuss the data.

**Quantitative Terminology**

- Construct validity – Establishing specific operational measures to lower researcher bias and subjective judgments.
- Internal validity – Establishing of causal relationships in order to test the validity of inferences.
• External validity – Establishing a domain to which the study’s findings can be generalized.

• Reliability – Establishing data collection procedures to ensure that data collection can be repeated with the same results.

Qualitative Terminology

• Credibility – The documentation of the process and procedures used in the gathering and analyzing of data.

• Transferability – The data and descriptions provided by the study are rich in detail and would allow other researchers to transfer the information to other settings.

• Dependability – How does the change in the setting affected how the research was conducted.

• Confirmability – The process and procedures for checking the data throughout the study.

Data Verification

Qualitative research is sometimes criticized because the data are gleaned from perceptions and observations rather than facts. Typically the quality of a research design is based the criteria of validity and reliability commonly associated with quantitative research. Yin (2003; 2009) provide measures for dealing with the four tests of construct validity, internal validity, external validity, and reliability as they apply to qualitative research. Yin’s measures for dealing with these four tests can be considered controversial since they are typically associated with quantitative research, not qualitative research. So the criteria of credibility, transferability, dependability and confirmability, which are typically associated with qualitative research will also be referenced in addressing these four tests (Guba, 1981; Guba & Lincoln, 1989). The
analysis of data is described in quantitative terms while the case study itself is described in qualitative terms.

The first test of quality is construct validity. In order to meet the test of construct validity, the design of the study must be specific as to the sources of data collected and check the data sources for correctness as well as how the data links together. To increase construct validity the researcher uses multiple sources of evidence, creates a chain of evidence, and maintains a case study report (Yin, 2003). This study used multiple sources of evidence that included interviews, observations, and document analysis. The researcher created a chain of evidence by linking the questions asked during the interviews to the data collected from the observations and documents analyzed. The chain of evidence created a direct link from the research questions to criteria on both the observation instruments and the document analysis instrument. A case study report was written for the case and used to improve construct validity. The case study report also addressed the issue of confirmability so that assertions from the data analysis were linked both by the chain of evidence and by the data gathered from the participants and not solely based on the interpretations of the researcher (Lincoln & Guba, 1985).

The second test of quality is internal validity, which is typically only an issue when the researcher has to infer about information that was not directly observed (Yin, 2003). Merriam (1998) lists six ways to increase the internal validity of qualitative research: triangulation, member checks, long-term observation, peer examination, participatory mode of research, and researcher biases. This study used several methods to pass the test of internal validity including triangulation of data and member checks. Triangulation of data was achieved by using multiple sources of data and ensuring the data across all sources were corroborated. Member checks for this case study occurred when data were sent to the interviewees to check for accuracy. Three
interviewees responded to the member checks. The files were verbatim transcripts of interviews. The researcher assumed that nonrespondants had no issues with the transcripts. Triangulation and member checks were also used to establish credibility (Guba, 1981; Guba & Lincoln, 1989).

Since this was a single case study, external validity cannot be proven. In order to achieve external validity, future research using a multi-case study design and following replication logic will need to replicate similar findings of similar studies (Yin, 2003). External validity determines whether the case study has similarities beyond the original case(s) presented. Due to the nature of data and data analysis, case study research findings rely on analytical similarities found amongst the cases (Yin, 2003). To achieve analytical similarities, researchers need to replicate the results in additional cases. This can be done with replication logic using a multiple case study approach (Yin, 2003). The replication logic includes selecting cases that fit the same criteria for being an exemplary institution and using a case study protocol, which ensures that the same methods and procedures were followed for each ‘case.’ The data gathered for this study included detailed information of the case. This information allows for increased ability for the replication logic when selecting cases that fit the same criteria. This information also increases the transferability of the case to the reader (Lincoln & Guba, 1985).

The goal of reliability is to minimize both errors and bias in the study (Yin, 2003). In order to pass the test of reliability the case study should be able to be replicated on the same ‘case’ and receive the same results (Merriam, 1998). Multiple methods were used to achieve reliability for this study, including but not limited to case study protocol and case study database (Yin, 2003). The case study protocol was used for data collection and analysis. It ensured that the interview protocol remained constant and that the same instruments were used for observations and document analysis. A case study database was created for this study allowing
other researchers to access and review the data. This increases the reliability since it allowed other researchers to review the data in order to develop similar conclusions. In addition, member checks and a case study report were used to check the reliability of the interview information. The case study database and case study protocol increased the study’s dependability by allowing verification of the data collection methods, as well as establishing the study’s credibility through the documentation of the research techniques and methods used (Guba, 1981; Guba & Lincoln, 1989).

**Reporting**

Yin (2003) lists six ways to structure a case study report: linear-analytic, comparative, chronological, theory building, suspense, and unsequenced structure. For descriptive case studies an unsequenced structure is recommended for the organization of the case study report since chapters can be rearranged without altering the quality of the description (Yin, 2003). When using an unsequenced structure there is no ‘one-way’ to write a case study report, rather each report is tailored to the needs of the audience (Yin, 2003). Once an audience has been selected, specific components can be emphasized and a report developed (Merriam, 1998).

While there is no specific way of writing a case study report, this case study follows Merriam’s (1998) guidelines for a general organization format used when developing a report. Chapter one includes the purpose and significance of the study, provides a short literature review and theoretical framework, and contains an over view of the research methods. Chapter two is a review of the literature surrounding pre-service teacher preparation programs, research on educational technology, research focusing on using the TPACK model for evaluation of teacher preparation and technology literacy, model teacher preparation programs, and technology literacy standards. Finally, chapter three details the methodology section that begins with a brief
highlight of ‘case’ selection, methods of data collection, analysis, and verification (Merriam, 1998). Chapter four details the findings of the study. In the findings section, the findings are validated through references to and from the data. The final discussion in chapter five draws conclusions from the data and compares the findings with the literature (Merriam, 1998).

Anonymity and reliability must also be considered. Anonymity in a case study can occur at either the level of the entire case or that of an individual person within the case (Yin, 2003). Prior to data collection, permission was obtained for interviews and observations. Names of individuals and the program were coded for the purpose of confidentiality within the findings presented in Chapter Four.

Summary

This descriptive case study examined an exemplary teacher preparation program to determine how the program prepares pre-service teachers to be technology literate. The guiding questions for this study reviewed data pertaining to preparation experiences, technology standards, and documentation of proficiency preparation. This case study examined the MAU Teacher Preparation Program as the exemplary institution. Data were gathered using interview protocols, observation instruments, and syllabi evaluation checklists. The data were analyzed and using the tests of construct validity, external validity, internal validity, and reliability ensured the quality of the case study. Finally, data were reported through the creation of case study reports that were tailored to individual audiences.
Chapter 4 Data Analysis

This research examined the MAU Teacher Preparation Program. The researcher visited the MAU Teacher Preparation Program for a weeklong visit on February 21, 2011. The data collection included interviews conducted with faculty and instructors, classroom observations, and data analysis of course syllabi and accreditation documentation. An initial interview with the Director of Teaching and Learning who recommended research participants led to purposeful sampling for participants of this study, which included four instructors and five faculty members, observations in seven classes, and the collection of six syllabi.

Analysis of data and findings begins with the presentation of the observation and interview data. The data were compiled in a manner so that the findings are organized to fit into the Technological Pedagogical Content Knowledge Framework and continues with the presentation of the data gathered using three instruments. The Integration of Technology Observation Instrument was used to measure technology use based on the National Education Technology Standards for both teachers and students. The Snapshot Assessment Instrument was used for collecting data on the technology infrastructure of classrooms and computer labs. The Syllabi Evaluation Checklist was used to analyze course syllabi in order to assess which National Education Technology Standards (NETS) the course is addressing. These three instruments were selected to aid in collecting data to determine the level of technology integration within the MAU Program and technology integration and use by the faculty and students at the MAU Program. These instruments also were used to determine how closely the coursework at the MAU Program was aligned with the National Education Technology Standards (NETS).
The history of technology integration in teacher preparation programs paints a picture of the MAU Program. Distinctions are made across the three current options for teacher preparation: secondary education, elementary education, and special education. The data analysis begins with a brief explanation of the themes and categories that emerged from the data. This analysis is followed by a presentation of the findings delivered based on an analysis of the data using the TPACK framework designed by Mishra and Koehler (2006), the Integration of Technology Observation instrument, the Syllabi Checklist instrument, and the Snapshot Assessment Instrument. Finally, a summary of the findings and data analysis from this research is presented.

History of Technology Integration

According to Participant 2, the origins of technology integration in the MAU Teacher Preparation Program began in 1984 when a plan was developed to redesign it and place an emphasis on the themes of a focus on special education, multicultural education, and technology that would be integrated throughout the entire pre-service preparation program. In its endeavor to promote technology integration throughout the pre-service preparation program, three guiding principles were followed: 1) Focus on teaching with technology in order for students to learn rather than teaching specific technology use; 2) Develop partnerships with local school districts; and 3) Focus on educational technology by subject or content area. The success of the MAU Teacher Preparation Program can be attributed to its focus on technology integration, which has remained a part of the School’s mission for 30 years. Participant 2 notes the MAU Program’s success can be attributed to a sustained commitment to technology integration: “I think that we have been fortunate to have stability in direction in leadership that has been a key part of this that has made it possible” According to Participant 2 the culture of the MAU Teacher Preparation
Program has evolved over a 30 year period and is “still something that is evolving because the school and how we organize ourselves has evolved and the face of technology has evolved over the course of the last three decades as well.” The results of the redesign of the MAU Teacher Preparation Program and the evolution of 30 years of a culture of technology integration has transformed the pre-service preparation program into what it is today. At the time of this study, the MAU Teacher Preparation Program offered three teacher preparation programs (elementary education, special education, and secondary education).

Technology Coursework in the MAU Program

Currently the MAU Teacher Preparation Program offers two courses that focus on technology. The remaining coursework in each teacher preparation program focuses on content, pedagogy or content and pedagogy. Although the other courses within the program of study do not specifically address technology, the program itself is directed by one of the three guiding principles: Focus on educational technology by subject or content area. This has led to evidence of technology being integrated throughout the courses in this program which is further detailed later in this chapter.

Table 1 provides a brief overview of the two technology courses offered at the MAU Teacher Preparation Program. The first course, EDIS 3450 (Teaching with Technology), is currently offered in three sections. One section is for math and science majors, one section is for English, social studies and foreign language majors, and one section is for elementary and special education majors. EDIS 3450 is required for all education majors. The second course, EDIS 5440 (Applied Teaching with Technology), is required for students in secondary math and optional for all other students. Each course consists of differing content, assignments, assessment, and approaches to teaching technology literacy and integration. Every pre-service
teacher must enroll in EDIS 3450 (Teaching with Technology) during their third year in the
program, which is currently offered in three sections. Participant 2 oversees all three teaching
with technology courses and the applied teaching with technology course, which are taught by
his doctoral graduate assistants.

Table 1. 
*Technology Course Descriptions*

<table>
<thead>
<tr>
<th>Course Prefix and Number</th>
<th>Course Title</th>
<th>Catalog Description</th>
<th>Sections</th>
</tr>
</thead>
</table>
| EDIS 3450               | Teaching with Technology          | This course provides an introduction to effective, standards-based methods of integrating technology into the classroom, focusing on approaches specific to each content area. Prerequisite: Admission to Teacher Education Program. | 1. Elementary and Special Education  
| EDIS 5440               | Applied Teaching with Technology  | This course provides a semester-long internship with a teacher in a K-12 classroom coordinated with accompanying coursework. It provides an applied experience in developing a technology project in a classroom setting and addressing curricular standards through integration of educational technologies | Required for students in secondary math; optional for all other students |

The EDIS 3450 course is aimed at helping pre-services teachers meet the National Education Technology Standards (NETS) for teachers that were developed by the International Society for Technology in Education. The teacher preparation program has designed the course to be separated by discipline, and the information received in the technology specific courses are linked to the methods course. This alignment allows the students to receive the content specific technology skill training within the technology classes while the methods courses focus on
pedagogy and content. Each section of EDIS 3450 relates to a specific content area which means that although the classes are designed to address the ISTE standards, the actual design and development of each class is different. According to Participant 2, “We work very closely with ISTE, we are a recipient of the ISTE best practice award for the integration of technology in the MAU teacher preparation program. Generic uses of technology are not going to get us where we need to be. We organize around the pedagogy of a specific content area in how we integrate technology.” This philosophy led to the design of technology courses focusing on teaching integration of technology to enhance learning, rather than focusing on teaching proficiency with specific software programs and digital technology devices.

The EDIS 5440 course (Advanced Teaching with Technology) is offered during the students’ fourth year in the program and is taught by Participant 11 who stated that the class was developed based on the ISTE NETS-S and NETS-T standards, and the course is designed and developed based on the TPACK model. EDIS 5440 is attached to a field experience and is optional for all students with the expectation of those in the math program for whom it is required. Typically the students who enroll in it enter field during their fourth year that results in students combining the technology course with the field experience.

Unlike EDIS 3450 whose classes are separated by major, EDIS 5440 has a broad spectrum of students from different content specializations and grade levels. The coursework of the class consists of projects. Participant 11 discussed the structure of the class by stating, “I ask them to look at the state’s Standards of Learning (SOLs) and the state SOLs do not have a technology component to it so getting the students in my class to look at what they are creating lesson wise that uses technology matches what ISTE has as well as the State SOLs. The class is structured both around the student’s current interests and what they are working on in their field
experiences, as well as on certain core topics such as digital copyright and creative common licensing laws. The coursework is generally base around a tool, a philosophy, or an idea I try to gear it around TPACK and in some respects I try to gear it around technology that I think will be beneficial to their classroom use.”

EDIS 5440 (Applied Teaching with Technology) was held in Miller Hall, room 209, which is one of the two computer labs located within the MAU Teacher Preparation Program. The topics covered in this class during the classroom observation dealt with interactive communication in the classroom with tools such as Skype, YouTube, TeacherTube, and other sources of video media. The instructor began the lecture by reintroducing the class to the concept of TPACK. The presentation then discussed the various types of interactive communication mediums and examples of interactive video. The class followed the lecture by viewing the presentation on their computers. Questions asked by the students were emailed to the instructor during the lecture and were answered at the conclusion of the lecture. In addition, a portion of the lecture was a refresher on fair use and copyright laws when using video and pictures from the Internet.

Middle America University’s School Teacher Preparation Programs

The Middle America University’s teacher preparation program is a five-year program. Upon graduation each student earns a Bachelor’s degree in a content area as well as a Masters in Teaching. The program is not designed to allow students to receive four years in their content area and one year in the College of Education. Instead the program is designed so that students begin taking their education and content courses during their second year. In the third year, students take their first technology class. During the fourth year, students have methods courses and so on. In the fall of their fifth year, final student placement occurs. In addition to the
content major area of study, students choose one of the school age range areas of study: secondary education or elementary education with special education that is housed within the elementary education program.

Secondary Education

In the secondary education program, future teachers take specific methods courses in their content area, age level pedagogy coursework, and field experiences tied to their content methods courses. In the secondary education program students receive content knowledge from coursework in the college of their major. Math majors take content courses in the math department; social studies teachers take content courses in the history department, etc. During the students’ fourth year, they take a yearlong sequence of content methods courses in the MAU of Education. It is in these classes that they receive their Technological Pedagogical Knowledge. The content methods courses use the standards set by the national organizations in their respective content areas. There are no technology standards required by the state, the university, or professional organizations.

Elementary Education

In the elementary education program, students have their own age level pedagogy coursework, content methods courses in all of the core content areas and field experiences tied to math and reading. In the elementary education program pre-service teachers are required to receive training in the core content areas of language arts, math, social studies, and science. Language Arts consists of a three course sequence: Block I, Block II, and a reading course. Math is a three course sequence in which students take MAT 1150 (Shapes and Space), a geometry course, MAT 1160 (Numbers, Patterns, and Functions), an algebra course, and an elementary math methods course. Social Studies is a three course sequence of HIUS 2001
(American History), HIEU 2001 (Western Civilizations), and an elementary social studies methods course. Finally, science consists of an elementary science methods course (Rector and Visitors, 2011a).

Special Education

Middle America University adheres to state requirements so that students in the special education program must get a primary license in either secondary or elementary education and a secondary license in special education. If the pre-service teacher is in the secondary education program they must get their primary license in a content area and a secondary license in special education. Pre-service teachers can also get their primary license in elementary education and their secondary license in special education. At the time of this study the special education program was housed within the elementary education program.

The three programs available in the MAU Teacher Preparation Program are for pre-service teachers interested in teaching at the elementary level, secondary level, or in special education. Within the elementary and special Education programs, the program of studies for pre-service teachers has little to no variation. However, within the secondary education program the curriculum has more variation because the course requirements change within the program depending on the pre-service teacher’s content specialization.

For the purpose of developing technology literacy, the MAU Teacher Preparation Program has changed how they sort their students from the areas of study to grouping them by elementary and special education, secondary math and science, and secondary English and social studies.
Themes and Categories

During the data analysis process themes were generated based on the codes produced as part of the analysis process. Data were gathered using formal interviews, observation checklists, and document analysis. During the analysis interview transcriptions were coded and put into the broad categories. For each participant, the codes within each category were compared in order to determine themes. The major themes that emerged from the data analysis included technology integration throughout the program and the TPACK framework. An additional theme of university collaboration emerged from the data analysis that was not connected to the structure of the instruments used in this study.

Data Analysis and Findings

The data gathered consisted of formal interviews, observations, observation instruments, and document analysis. Table 2 represents the participants and the types of data collected for each participant. The reader should be aware that the data gathered from this study comes primarily from information gathered by participants in the field of technology and secondary education (primarily secondary math and science). Upon completion of the interview with the Director of Teaching and Learning, the participants for the study were selected based on faculty and instructors that taught technology courses or content methods courses. Of the respondents from the request for participants of this study, only faculty and instructors in the areas of technology, math and science agreed to participate. One participant from the content area of English agreed to be a participant only after being approached by the researcher during the study.
Table 2

*Data Collection*

<table>
<thead>
<tr>
<th>Participants</th>
<th>Content Area</th>
<th>Status</th>
<th>Interview</th>
<th>Observation</th>
<th>Syllabus</th>
<th>Technology Observation</th>
<th>Instrument</th>
<th>Snapshot</th>
<th>Instrument</th>
<th>Peer Data</th>
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</thead>
<tbody>
<tr>
<td>1 Director of T&amp;L</td>
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<td>2 Technology</td>
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<td>4 Elementary Math</td>
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<td>6 Science</td>
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<td>7 Science</td>
<td>Graduate Student</td>
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<td>8 Technology</td>
<td>Graduate Student</td>
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<td>9 Technology</td>
<td>Graduate Student</td>
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<td>10 Technology</td>
<td>Graduate Student</td>
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<td>11 Technology</td>
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<td>13 Elementary English</td>
<td>Faculty</td>
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<td>14 Secondary Social Studies</td>
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<td>15 Elementary Social Studies</td>
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<td>16 Foreign Language</td>
<td>Faculty</td>
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</table>
Observation and Interview Data

Data collected for the purpose of the study included interviews of faculty and instructors and observations of technology and content area courses within the MAU Teacher Preparation Program. The data gathered from the interviews and observations was compiled and analyzed through the lens of the TPACK framework. Data gathered from interviews and observations were organized using this method in order to discover how the MAU Teacher Preparation Program achieves TPACK as a whole as well as looking how the school addresses teaching the relationships of domains of knowledge of Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK).

Technological Pedagogical Content Knowledge

The TPACK framework was designed as a tool in developing the knowledge for teachers to integrate technology into their practice (Mishra & Koehler, 2006). Technological Pedagogical Content Knowledge is the complex interplay of the three domains of technology, pedagogy, and content. Furthermore one who practices the use of TPACK is able to achieve technology integration by developing curricular units that use technology to enrich and enhance the curriculum through the proper selection of technology appropriate for the content and has the pedagogical skills to seamlessly integrate technology in the unit of instruction. Mishra and Koehler (2006) discuss the importance of looking at the TPACK framework first as it relates to the relationships of domains of knowledge of Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), and Technological Content Knowledge (TCK).

Data and analysis are also be presented based on the TPACK framework (Mishra & Koehler, 2006), the framework chosen by the MAU Teacher Preparation Program to guide their decisions in how they integrate technology. According to Participant 2, “I think that our focus
on effective ways to integrate build on the American Association of Colleges of Teacher Education’s TPACK concept. The Association for Educational Communications and Technology published the handbook of TPACK that established the theoretical foundation that stated pedagogy, content, and technology must be addressed simultaneously; further corollary of that concept is how this is best completed within each content area so the content drives how the technology is being used.

Pedagogical Content Knowledge

Shulman’s (1986) research on teacher education found that pre-service teacher education programs tended to focus on either content knowledge or pedagogical knowledge. Shulman (1986) developed the concept of Pedagogical Content Knowledge (PCK) which states that pre-service teachers need to develop both of these domains of knowledge in order to learn the skills and strategies for knowledge acquisition in their particular content area.

The MAU Teacher Preparation Program’s teacher preparation program is designed so that students receive a degree in their content area and a Master’s degree in teaching. Students in the program receive their content knowledge from coursework within the college of their major (e.g., pre-service teachers planning on teaching science receive their content knowledge in science courses taught within the College of Sciences). During the fourth year, students take content methods courses taught within the College of Education. It is within these content methods courses that pre-service teachers receive their Pedagogical Content Knowledge or the instructional strategies most effective in helping students learn the content of a particular discipline.
Technological Content Knowledge

The domain of Technological Content Knowledge (TCK) is an understanding of the influence of interaction between technology and specific content subject areas (e.g., English, math, science, etc.). Knowledge of this domain includes the acknowledgement that technology can both drive and affect content as well as the understanding that the type of content taught will influence how the technology is used. Within the MAU Teacher Preparation Program, TCK is addressed through EDIS 3450 (Teaching with Technology). The EDIS 3450 course is offered for elementary and special education majors, English and social studies majors, and for math and science majors. Though the courses share similar aspects and topics of study each course is designed to focus on technology specific to its discipline.

Elementary and Special Education Technological Content Knowledge

Participant 10 teaches the EDIS 3450 course for elementary and special education majors. The course is designed to cover relevant technology that elementary and special education pre-service teachers can easily access and learn. There is no official textbook; rather course content is taught through the introduction of technology tools relevant to the students’ discipline and activities within the program. The instructor’s approach to the class is focused on experiential learning using the technology. This approach is used to introduce teachers to technology relevant and useful in the class room as well as to make technology less innocuous so that the pre-service teachers are more likely to use technology in their classrooms. Authentic learning scenarios and design challenges are used in preparing these pre-service teachers in being technology-literate.

An example of how the instructor introduces relevant technology and demonstrates how the technology can be used through learning scenarios and design challenges was demonstrated
during the social studies topic during weeks five and six. Week five focused on teaching elementary social studies content. The course began with a discussion of the states’ Social Studies Standards of Learning (SOL), followed by the application of the TPCK framework in the necessary technological knowledge, pedagogical knowledge, and content knowledge. Since the topic was social studies the information disseminated revolved around the use of digital images to teach social studies.

Participant 10 introduced several different types of technology during the class. The first technology introduced was Virsona, a website where students can create virtual personas to chat with historical characters. The second technology discussed was Diorama Designer, a software program designed to create historical images then print them either as 2-D images or as 3-D objects using a digital fabricator. Finally, students were introduced to maketolearn.org, a website dedicated to digital fabrication. Once these technologies were introduced the class was given a learning scenario.

The learning scenario for week five utilized the states’ Social Studies SOLs; students were given the assignment of designing a diorama, posting the lesson on the class blog, and posting their thoughts about using Diorama Designer on maketolearn.org. The lesson was designed to continue into week six.

The design challenge occurred in week six. Students were introduced to a program called Silhouette Studio, a software used for digital fabrication. A digital fabricator is a special type of printer that uses a small blade to cut out designs and objects on paper, card stock, or other types of materials. The design challenge required students to use Silhouette Studio and a digital fabricator to create a name tag for themselves.
English and Social Studies Technological Content Knowledge

Participant 8 teaches the EDIS 3450 course for English, social studies, and foreign language majors. A typical class session consists of a discussion of a scenario flashback of last week’s lesson, devoting time to learning a specific technology use, and ending with the introduction of the next technology which focuses on either new technology for the student or on new ways to use a specific type of technology. During class students are presented with a scenario of typical experiences that a pre-service teacher will encounter in the field. The students are then tasked to take the lesson in the scenario and discover ways to enhance the lesson so that it is transformed into a technology rich lesson. Participant 8 stated that his main goal is to “get them to innovate with technology…to think more critically about technology use in the classroom.”

EDIS 3450 (Teaching with Technology) was held in room 209 of Miller, which is one of the two computer labs located within the MAU Teacher Preparation Program. The class topic was wikis. The instructor had created a wiki using PBworks and explained to the class that he chose the wiki because it was free and non-platform specific, something that they should consider when adopting new technology when they become teachers. The class consisted of four mini-lectures that included a demonstration of an online tool, a wiki, use of a SMART board, concept mapping tools, and Mishra and Koehler’s (2006) concept of TPACK.

Class began with a lecture and demonstration of the wiki. The instructor used the SMART board to display information to students in the class. The lecture did not rely on the instructor disseminating information; he modeled the information presented to the students. The lecture not only covered an overview about wikis in general, it also included information concerning basic navigation and tools needed for students to create their own wiki. A specific
topic included how to imbed media in a wiki. The lecture included a refresher on digital copyright laws. At the conclusion of the lecture, the instructor gave the students an opportunity to make their own page by utilizing a scenario in which they had to create a wiki intended for the classroom. As part of the scenario, students were tasked with embedding video, pictures, and hyperlinks into the wiki as part of their assignment. Time was allotted for students to begin working on the assignment in class, and the instructor offered personal assistance to the students to see if they had any questions concerning creating a wiki. Before this portion of the class had concluded, students were tasked to embed one video into their wiki and to present it to the class.

The second lecture in the course dealt with a demonstration of some of the tools built into the SMART board that can be used with English courses. The lecture focused on two particular tools; the highlight tool and zoom functions. The instructor also demonstrated the clone tool and how a teacher could set up several text boxes with words to be used for the lesson. The instructor showed how a teacher could create a lesson where students would fill in a blank in a sentence. The clone tool allows students to grab and drag a clone of the textbook and place it in the appropriate ‘blank’ in the sentence. The last portion of the class focused on the concept of TPACK (Mishra & Koehler, 2006) and an introduction to a concept mapping tool called Inspiration.

While the instructor was lecturing on the concepts of TPACK, he utilized the William & Mary School of Education web page to introduce the different domains of the conceptual framework. At the conclusion of the lecture, the instructor introduced concept mapping software. The instructor introduced the class to four different types of concept mapping software, primarily focusing on a concept mapping software called Inspiration. The instructor explained that there are two versions of this software. Inspiration is designed for postsecondary users but
also has a version designed for K-12 users. The instructor explained that all of the lab computers at the MAU Teacher Preparation Program were loaded with this software. The instructor modeled how the software could be used in its primary capacity of a concept mapping tool, and how once completed, there was a feature to turn the concept map into an outline. The instructor also discussed some free concept mapping software: Bubbleus, Smart-Art, and Presic. The instructor provided the URL for the free software and provided a brief demonstration of each of them. The class concluded with the instructor reminding the students about the wiki assignment and the need to embed the various types of media in their wiki.

Math and Science Technological Content Knowledge

Participant 9 teaches the EDIS 3450 course for math and science majors which focuses on technology useful to pre-service teachers. The coursework is structured so that the technologies build upon one another. The students not only learn about the different technologies, the class is designed so that students are given activities that provide them with an opportunity to use the featured technologies. Though some components of the class focus on technological knowledge, the primary focus is on how to integrate the technology into the content. Participant 9 further explained the introduction of technology knowledge by stating, “I will show them quickly how to use it, I am not into regurgitating information, then I have them try it, then I want them to tie it into their content knowledge.” Another focus of the class is building the pre-service teachers’ ability to find and use new technology. Since technology is ever changing it is a goal of the instructor to instill within the students the habit of staying abreast of technology.

EDIS 3450 (Teaching with Technology) was held in room 209 of Miller Hall, which is one of the two computer labs located within the MAU Teacher Preparation Program. The class
began with the instructor introducing Survey Monkey, a web-based survey software, and having students sign up for a free account. The instructor then demonstrated how to create a survey using Survey Monkey. Once students set up an account, they created a simple survey to be distributed to their peers and took one another’s surveys. The instructor then showed students how they could access and use their survey results. Time was then allotted to allow the students to write and send an email to the instructor on how they could use Survey Monkey in their future classroom.

The remainder of class time was spent on student presentations. During the day of observation, students taught five lessons. First, the instructor had the presenters use a program called Dropbox to store their class assignments. Students had to access their online storage space and retrieve their lesson. The students then taught the lesson using the SMART board.

The first presentation was a lesson on using money. The presenter used the National Library of Virtual Manipulatives website to teach the lesson on how to count money. The presenter also showed how the lesson could be adapted for students in special education. The second presenter also gave a math lesson that used the SMART board. With this lesson the presenter created a math game where the presenter used her fellow classmates as ‘students’ and asked them to take turns playing the game, which showed how she would use the class as an interactive part of her lesson. The third presenter taught a language arts lesson. The presenter showed the class how to decode multi-syllabic words. The presenter used the SMART board software to create multi-syllabic words that could be broken and moved around. Then the class became part of the lesson by having them come up to the SMART board and move the words apart. At the end of the presentation the instructor also modeled additional features of the SMART board showing how the lesson could be enhanced using the zoom, highlight, and
cloning tools. The fourth presentation was another demonstration of how the SMART board could be used to teach a math lesson and focused on graphing. The presenter showed some of the graphing tools that come with the SMART board software. At the end of the presentation the instructor modeled how to enhance the lesson by using SMART Notebook, the software used to create the lessons on the SMART board, by creating a cheat sheet of different arrows and symbols meant that were used for the lesson. The final presenter gave a geometry lesson on the SMART board. The presenter taught a lesson about circles focusing on diameter, radius, and area by using the example of pizza and working at a pizza parlor. The presenter had the students manipulate the pizzas and compare areas, diameters, and radii of the different pizzas by manipulating them on the SMART board.

At the end of the presentations the instructor showed the students additional features of the SMART board. The class ended with the students turning in lesson plans to the instructor for next week’s class.

Technological Pedagogical Knowledge

The domain of Technological Pedagogical Knowledge (TPK) refers to the ability to use technology in an educational setting. TPK is the understanding of how technology affects both teaching and learning. TPK is also knowledge of the various technological tools and resources that are available. TPK is addressed in the MAU Program within the pre-service teachers’ content methods courses. However, due to the nature of the crossover in assignments between the content methods courses and the EDIS 3450 course, acquisition TPK occurs within the EDIS 3450 course as well.
English Technological Pedagogical Knowledge

Participant 12 teaches the EDIS 5400 and 5401 courses (Teaching English in Secondary Schools I & II). EDIS 5400 and 5401 are three credit hour courses, which also have an additional one credit hour lab that is held in the computer lab. Classwork is designed to address the development of English pedagogy by emphasizing individual projects that focus on authentic learning objectives, assessments and technology integration. Participant 12 stated the following concerning their integration of technology: “I do make maximum use of the technology that is loaded into the classroom such as the internet, DVDs, and podcasts. What I try to do is model technology integration in the way that I want them to be thinking and working with students.” Permission for a formal observation was not obtained for EDIS 5401. However, while the researcher was conducting the Snapshot Assessment Instrument, the EDIS 5401 was taking place and a brief observation of this class did occur. During this observation, participant 12 was giving a lecture and using a desktop computer and projector built into the classroom to show a PowerPoint presentation.

The lab class is designed to allow students to use the lab in order to complete a research project. Once students have made a final decision concerning their research focus, they are asked to determine the technology needed to accomplish their project.

Participant 13, Chair of the Curriculum, Instruction, and Special Education Department, teaches courses in reading and language arts in the elementary program and was not a participant of this study. However, participant 13 was noted by a peer (Participant 6) for their use of technology integration in their course, their research into digital textbooks, their work in promoting the distance education programs in reading education, and their work as a member of the Children’s Engineering program.
**Social Studies Technological Pedagogical Knowledge**

Participant 14 has been noted by their peers for their technology integration in the secondary social studies methods course via interview. According to Participant 12 in regards to Participant 14, “I would say Participant 14 is just as tech savvy as I am and I would say even more so, and I know that she makes concise choices to use it.” A publication by Bell & Hofer (2003) also noted Participant 14’s technology integration. Participant 14 was contacted to be in this study but declined.

Participant 15 teaches the social studies methods courses in the elementary program. Participant 15 is listed as center faculty for the Center for Technology and Teacher Education, whose mission is to “identify and explore innovative digital technologies.” Participant 15 was invited to be in the study, but no reply was received.

**ESL Technological Pedagogical Knowledge**

During the interview process an additional faculty member was recognized for technology use. Participant 16 teaches courses in the area of English as a second language and supervises pre-service teachers during their field experiences. According to Participant 12, “One person who does use quite a bit of technology is in foreign language… she also directs the field placements so she is having students doing DVD’s of their instruction, creating portfolios of their work.”

**Math Technological Pedagogical Knowledge**

Participant 3 teaches EDIS 5450 and 5451 (Teaching Mathematics in Secondary Schools I and II), a yearlong block of courses. Participant 3 described their class as two strands. The first strand deals with the pedagogy of mathematics and working with pre-service teachers instructing them how to teach math problem solving skills. The second component is technology, which is
imbedded throughout the course. A portion of every class session is dedicated to technology. The courses are designed to be taught in a sequence and are tied to EDIS 4884, Field Experience: Mathematics Education. Class periods are dedicated to a mathematical concept and an introduction of new technology that coincides with it. The EDIS 5451 class observed for this study consisted of student presentations. All of the presenters used the SMART board to teach their math lessons. However, presenters also accessed websites to show simulations and access math skill building games, display video clips, and use Geometer’s Sketchpad.

The coursework consists of a progression of math concepts. During the spring semester the coursework focuses on the mathematical concepts of recursion, probability and statistics, followed by mathematical functions with multiple representations and trigonometry in February, geometry and calculus in March, and probe-ware and other technologies in April. Participate 3 stated that the following concerning the structure of the class: “Now most of the time, we are dealing with our math topic. I will give them a problem or a topic and we will talk about their understanding and how they would teach it, then I will bring technology in. Everything that they learn is connected to a task that they might use in the class. This way it is real to them, they see the value in using it, they see how the technology helps them to do better.” Throughout the semester students are required to design and teach three lessons. The class observed by the researcher was one of the classes dedicated to student presentations of one of their lessons, which were recorded using a flipcam (a small digital video recorder). According to Participant 3, the students will watch and critique these videos during the next class to help them improve their teaching and presentation styles.

EDIS 5451 (Teaching Mathematics in Secondary Schools II) was held in one of the two computer labs in room 233A in Miller Hall. During the class observed by the researcher,
students conducted a lesson using a SMART board. Each student gave a ten-minute lesson based on the math subject area they planned on teaching. At the end of the presentations there was time for questions and comments by the other students in the class, which was facilitated by the instructor. In addition, the instructor took some time to demonstrate additional uses for the SMART board and provided additional technology training.

Two additional courses are required of pre-service teachers in the secondary math program, EDIS 3450 (Course Title) and EDIS 5440 Applied Teaching with Technology.

Participant 4 teaches EDIS 5320 (Math in Elementary Schools). “The focus in my class is on the content with the technology supporting the content. So what my students do is at the beginning of the semester I have my students do an annotated bibliography. I present them with a range of mathematic topics or concepts and from the annotation they are required to find ten articles on the topics of teaching and learning of mathematics. So technology is somewhat interwoven through that, but I probably use the SMART board in every class. I use virtual manipulatives, and what I do is I contrast the virtual tool with the actual virtual tool. I try to get them to think critically about what are some of the limitations of the virtual tool and what are some of the limitations of the hands on tool, and when it is appropriate to use either one, whether together or independent of one another.” Participant 4 also discussed how they try to contrast virtual tools with hands on tools, which allows students to gain two different perspectives. First, they see how they could teach the same lesson if they did not have access to the technology and secondly, they see ways that they might enhance lessons using technology.

EDIS 5320 (Mathematics in the Elementary School) was held in room 241 of Miller Hall. The class that was observed covered the math topic of process standards. The first topic presented in class did not focus on math; rather the class was given a handout developed by a
former student. This handout was a cheat sheet on the topic of behaviors to avoid during a special education meeting talking about special education students’ Individual Education Plans (IEP). The remainder of the class focused on a math topic.

The math topic for this class was developing meanings for problem structures in addition, subtraction, multiplication and division. This class covered how to teach children about making connections between the four different problem structures so that they can use all of them to solve real world math problems. The class contained some elements of lecture, but was primarily a series of problems that were presented to the students. During the lecture part of the class the instructor used the SMART board to illustrate the concept of the topic being discussed. Later during another portion of the class a PowerPoint presentation was given by the instructor using the SMART board to interact with the presentation. The students worked to solve problems in groups while the instructor facilitated a discussion.

The first problem the students were given dealt with baseball. The students were given information about the dimensions of a baseball stadium. Then they were told that a baseball player hit a home run to right field and it went just over the bottom wall of the stadium. They then had to figure out how far he hit the ball, how far he ran, and the angle of the ball. After they solved the problem, the class discussed how they solved it, the process standards they used to solve the problem, and how they would use this information in teaching their students about making the connections between process standards to solve a real world problem. The instructor also showed the students how they could solve this problem using some of the special functions on a graphing calculator.

The second problem that the class worked on was an ‘orange’ problem, which required the students to work in groups and review the state math standards to determine if the problem fit
within them. Once this was determined, the group had to determine if the problem met the process standards and if so, how.

The third problem students were given was a real life sample of a math problem that a student did not solve correctly. The class worked in the same groups to determine how the student got the answer wrong. The purpose of this exercise was to determine how the student made the mistake so that they would know which step of the process needed to be reviewed again. Each group used the SMART board to show how they thought the student solved the problem and where they thought the student made an error.

The final problem the class worked on dealt with The Kids, a fictional group of students with special needs. This exercise is designed to assist the pre-service teachers in considering planning lessons for future classes that may include students with special needs. Each class devotes a portion of time to modifying and adapting a lesson for ‘the kids.’ A description of each special needs student includes his or her strengths and weaknesses. Each week the students modify assignments for a different special needs student. Each student used the SMART board to go through the lesson and determine which ‘kids’ would be challenged by the tasks. The students then went back into their groups to determine which accommodations or modifications would be needed. This problem concluded with each group giving a brief presentation about the modified the lesson. The class concluded with a final lecture and facilitated discussion by the instructor.

The final lecture of the class focused on making connections between math and culture. The instructor used the SMART board to show the primary dimensions of diversity wheel, as a way to get the students to stop thinking about diversity in terms of race, but instead to think about diversity as an individual’s set up experiences and beliefs. In addition, a PowerPoint
presentation showing how culture overlaps with the National Council of Mathematics Process Standards was given. At the conclusion of the lecture, the instructor facilitated a discussion concerning differing traits of various ethnic groups, how they overlap with process standards, and why it was important for teachers to be mindful of culture in regards to the process standards.

*Science Technological Pedagogical Knowledge*

Traditionally an instructor teaches EDIS 5050 and 5051 (Teaching Science in Secondary Schools I and II). However, during the time of my observation, participant 5 co-taught EDIS 5050 with participant 7, and EDIS 5051 was co-taught by participant 5 and participant 6. Miller Hall Room 218A was equipped as a fully functioning science lab that can be used for both biology and chemistry. The room is also equipped with a computer next to each lab station, a SMART board and a projector. The course focuses on teaching the pedagogy of science education. Participant 5 explained that the class structure “is always foremost the science and the teaching of the science, but we try to seamlessly integrate the technology and how technology is a tool that you can use within certain teaching techniques. Within the science methods course we try to seamlessly integrate technology in to the class as much as possible. We have certain dedicated class time for certain technology such as the SMART Board, collaborative technology, or visualizations within science, digital microscopes, and digital pictures. There is definitely a range in terms of the technology that we use.”

EDIS 5051 (Teaching Science in Secondary Schools II) was held in room 218A of Miller Hall, a fully equipped science classroom. The class began with a short lecture by Participant 5 who offered advice to the students in the class. They discussed that the two foci of the class is science and science technology, which is why they are being prepared to use technology when
they leave the MAU Program. The class was then given a book written by participant 5 titled *The Nature of Science*. A PowerPoint presentation about the book and the use of simulation software to show the inside of an atom was given. The book also provides web resources for other simulations that can be presented to students using technology. Participant 6 and participant 7 team taught the remainder of the class using a PowerPoint presentation. The class concluded with students being placed in groups to work on an educational scenario.

The scenario began by placing students into groups and assigning the task of forming a square within the group without talking. The goal of the exercise was to provide some background knowledge, facilitate a discussion about active members of groups, and how as future teachers they need to consider the dynamics of choosing groups for student projects. The groups were then given a scenario called the NASA moon simulation.

The NASA moon simulation is a website where students pretend they are a space crew who crash lands and have to hike 200 miles to get to the base. The students in the group have to rank order fifteen items to determine what they should or should not take for trip back to the base. Part of this assignment requires students to make decisions on the rank ordering by group consensus. Thus, students must provide rationalizations and arguments to defend their stances on the rank order.

Interview and Observation Findings

The data gathered from the interviews and observations was organized through the lens of the TPCK framework (Mishra & Koehler, 2006). The data were organized using this method in order to discover how the MAU Teacher Preparation Program achieves TPACK as a whole how individual domains are addressed, and how the relationships of domains of knowledge are taught.
An analysis of the data from interviews and observations demonstrates evidence that the MAU Teacher Preparation Program achieves TPACK by addressing the relationship between the domain of TPK and TCK for students in the elementary and special education emphasis, secondary math and science emphasis, and secondary English and social studies emphasis (see courses in the MAU Teacher Preparation Program that cover areas of TPACK in Appendix F). The data gathered from the interviews and observations provides evidence that the activities and coursework within the courses in the teacher preparation program address the domains in the TPACK framework (Mishra & Koehler, 2006). The data also shows that there is no single course in the MAU Teacher Preparation Program that addresses a specific domain of the TPACK framework. Instead data from the findings show evidence that both the technology coursework and content area coursework address multiple domains within the TPACK framework (Mishra & Koehler, 2006) so that TPACK is achieved through the relationships and interconnection between the technology course, content area course, and field experiences.

Data Analysis and Findings Using the Integration of Technology Observation

The Integration of Technology Observation Instrument was designed at Arizona State University as part of the PT3 grant; it was developed using International Society for Technology in Education (ISTE) National Educational Technology Standards for Teachers (NETS – T) and the National Educational Technology Standards for Students (NETS –S). The instrument was designed to observe technology integration and use by both teachers and students.

Integration of Technology Observation Instrument

The Integration of Technology Observation Instrument is used to measure technology use in three minute intervals. Technology usage is assessed based on the National Education Technology Standards for both teachers and students. The Integration of Technology
Observation Instrument measures the ISTE NETS-T standards two, Design and Develop a Digital-age Learning Experience, which looks at a teacher’s ability to use technology to design and develop learning experiences for their students. The instrument also measures standard three, model digital-age work and learning, in which teachers demonstrate knowledge and skills and the ability to model and facilitate use of technology for communication and collaboration using digital media and formats. The instrument also measures the following ISTE NETS-S standards: standard three, research and information fluency, in which students use technology to gather, analyze, and interpret information; standard four, critical thinking, problem solving, and decision making, in which students use digital tools for conducting research; standard five, digital citizenship, in which students learn about legal and ethical practices and use of digital information; and standard six, technology operations and concepts, in which students learn about specific uses of technology.

Comparison of the data gathered from all of the courses observed using the instrument show that technology integration and use occurred in all courses. However, technology use varied from course to course. Data from this instrument were also used to determine the technology usage by instructors and students, and the percentage of class time technology was used. Table 3 shows the results of the measurements by the instrument for each of the courses.
Table 3
Integration of Technology Observation Instrument Data

<table>
<thead>
<tr>
<th>Course Prefix, Number and Title</th>
<th>Instructor and Focus Area</th>
<th>Percentage of Class Time Instructor Used Technology</th>
<th>Percentage of Class Time Students Used Technology</th>
<th>Total Percentage of Class Time Technology Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDIS 3450: Teaching with Technology</td>
<td>Participant 8 Secondary English &amp; Social Studies</td>
<td>90</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>EDIS 3450: Teaching with Technology</td>
<td>Participant 9 Secondary Math and Science</td>
<td>85</td>
<td>10</td>
<td>95</td>
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<tr>
<td>EDIS 5440: Applied Teaching with Technology</td>
<td>Participant 11</td>
<td>80</td>
<td>65</td>
<td>100</td>
</tr>
<tr>
<td>EDIS 5451: Teaching Mathematics in Secondary Schools II</td>
<td>Participant 3</td>
<td>18</td>
<td>73</td>
<td>91</td>
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<tr>
<td>EDIS 5320: Math in Elementary Schools</td>
<td>Participant 4</td>
<td>75</td>
<td>10</td>
<td>85</td>
</tr>
<tr>
<td>EDIS 5051: Teaching Science in Secondary Schools II</td>
<td>Participant 4</td>
<td>75</td>
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<td>75</td>
</tr>
<tr>
<td></td>
<td>Participant 6</td>
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<tr>
<td></td>
<td>Participant 7</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Data collection consisted of a single observation of each course listed. The observation lasted the entire length of the class period. Data were collected at 3 minute intervals.

The Integration of Technology Observation Instrument was used to measure the percentage of time that technology was used in the classroom. An analysis of the data gathered using this instrument showed evidence of technology integration and use in all of the courses observed. Results from the instrument showed that in eighty-three percent of courses instructors were the predominant users of technology. Data analysis also showed that in only one course observed during this study lacked evidence of student technology use.
Data Analysis and Findings Using the Areas of T-PACK

The data gathered as a part of this study was analyzed using the TPACK framework. The analysis was further focused by examining the data as to how it applied to the specific domains of Technological Content Knowledge and Technological Pedagogical Knowledge. The data used for the analysis was gathered using the Integration of Technology Observation instrument, the Syllabi Evaluation Checklist, and the Snap Shot Assessment instrument.

*Elementary and Special Education Technological Content Knowledge*

Prior to data collection, the instructors teaching the EDIS 3450 courses were contacted in order to gain permission to interview and observe. The EDIS 3450 course taught by Participant 10 was unable to be observed, thus data were not collected using the Integration of Technology Observation instrument.

*English and Social Studies Technological Content Knowledge*

The EDIS 3450 course taught by participant 8 was observed using the Integration of Technology Observation instrument to measure the actual use of technology in the classroom. The class conducted at the time of the observation was held in one of the MAU Program computer labs and technology was integrated and used in the class 100 percent of the time. Technology use observed during data collection included the use of digital media and tools such as websites, images, and video. Data collected on observed technology use for each of the ISTE NETS standards is displayed in Table 4.
Table 4  
**EDIS 3450 (Participant 8)**

<table>
<thead>
<tr>
<th>ISTE NETS - T</th>
<th>Evidence</th>
<th>ISTE NETS - S</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 2:</td>
<td>Use of technology including:</td>
<td>Standard 3:</td>
<td>Student use of digital media including:</td>
</tr>
<tr>
<td>Design and</td>
<td>• Websites</td>
<td>Research and Information Fluency</td>
<td>• Videos</td>
</tr>
<tr>
<td>Develop</td>
<td>• Videos</td>
<td></td>
<td>• Images</td>
</tr>
<tr>
<td>Digital-</td>
<td>• Images</td>
<td></td>
<td>• Wikis</td>
</tr>
<tr>
<td>Age Learning</td>
<td>• SMART Board</td>
<td></td>
<td>Concept Mapping Software</td>
</tr>
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<td>Experiences</td>
<td>• Wikis</td>
<td></td>
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<tr>
<td>and</td>
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<tr>
<td>Assessments</td>
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<tr>
<td>Standard 3:</td>
<td>Modeled technology and used digital tools such as:</td>
<td>Standard 4:</td>
<td>Student use of technology in the development of instructional wiki</td>
</tr>
<tr>
<td>Model</td>
<td></td>
<td>Critical Thinking, Problem Solving, and Decision Making</td>
<td></td>
</tr>
<tr>
<td>Digital-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age Work</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and Learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard 5:</td>
<td>Lessons in copyright and fair use of digital material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citizenship</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard 6:</td>
<td>Student use of technology in the design and development of wiki</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and Concepts</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Math and Science Technological Content Knowledge**

The EDIS 3450 course taught by Participant 9 was observed using the Integration of Technology Observation instrument to measure the actual use of technology in the classroom. Most of the technology use consisted of presentations of the lecture and modeling technology use by the students. Technology use primarily consisted of the use of the SMART board for presentation of the student developed lessons. Throughout the class observation, both the instructor and the students also used the survey software Survey Monkey and a cloud software called Dropbox for the use of transferring their presentations. In addition to this software use,
students also used a variety of websites, digital videos, and digital images in the creation of the lessons they taught as part of their presentation. Data collected on observed technology use for each of the ISTE NETS Standards is displayed on Table 5.

Table 5  
**EDIS 3450 (Participant 9)**

<table>
<thead>
<tr>
<th>ISTE NETS - T Evidence</th>
<th>ISTE NETS - S Evidence</th>
</tr>
</thead>
</table>
| Standard 2: Design and Develop Digital-Age Learning Experiences and Assessments | Use of digital media including:  
- Websites  
- Videos  
- Images  
- SMART Board  
- Survey Monkey  
- Dropbox | Standard 3: Research and Information Fluency |

| Standard 3: Model Digital-Age Work and Learning | Modeled technology and used digital tools such as:  
- Survey Monkey  
- SMART Notebook  
- SMART Board | Standard 4: Critical Thinking, Problem Solving, and Decision Making | Student use of technology to create lessons presented in the class |

<table>
<thead>
<tr>
<th>Standard 5: Digital Citizenship</th>
<th>Lessons in copyright and fair use of digital material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 6: Technology Operations and Concepts</td>
<td>Student use of technology in the design and development of wiki</td>
</tr>
</tbody>
</table>

The EDIS 5440 course was observed using the Integration of Technology Observation instrument to measure the actual use of technology in the classroom. EDIS 5440 is open to any student in the teacher preparation program. However, students in the secondary math program are required to take this course. Most of the technology use was done by the instructor for presentation of the lectures and modeling technology use for the student teachers. Technology was integrated and used in the class 100 percent of the time. Technology use primarily consisted
of the presentation software and websites. Technology was modeled by the instructor in showing how to search and retrieve videos from the different sources presented in the lecture.

Data collected on observed technology use for each of the ISTE NETS Standards is displayed in Table 6.

Table 6
**EDIS 5440 (Participant 11)**

<table>
<thead>
<tr>
<th>ISTE NETS - T Standard</th>
<th>Evidence</th>
<th>ISTE NETS - S Standard</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 2: Design and Develop Digital-Age Learning Experiences and Assessments</td>
<td>Use of digital media including: • Websites • Videos • Images • Use of Web 2.0 Tools (e.g., wikis and blogs)</td>
<td>Standard 3: Research and Information Fluency</td>
<td>Student use of digital media including: • Videos • Images • Wikis</td>
</tr>
<tr>
<td>Standard 3: Model Digital-Age Work and Learning</td>
<td>Modeled technology and used digital tools such as: • Websites • Wikis • Blogs</td>
<td>Standard 4: Critical Thinking, Problem Solving, and Decision Making</td>
<td>Student use of technology to create lessons used in their field experiences</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lessons in copyright and fair use of digital material</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Student use of technology in the design and development of wiki</td>
</tr>
</tbody>
</table>

*English and Social Studies Technological Pedagogical Knowledge*

Prior to data collection, the faculty teaching methods courses in English, language arts, and social studies were contacted in order to gain permission to interview and observe. Permission was not obtained to observe any of the English, language arts, or social studies content methods courses.
Math Technological Pedagogical Knowledge

The EDIS 5451 course was observed using the Integration of Technology Observation instrument to measure the actual use of technology in the classroom. The class used for the observation consisted of students teaching lessons to the class. All of the student presentations consisted of technology use and modeling of lessons designed for the SMART board. Presentations also included the use of websites, videos and digital images, and the Geometer’s Sketchpad. Throughout the class the instructor modeled additional uses and tools built into the SMART board. Data collected on observed technology use for each of the ISTE NETS Standards is displayed in Table 7.

Table 7
EDIS 5451(Participant 3)

<table>
<thead>
<tr>
<th>ISTE NETS - T</th>
<th>Evidence</th>
<th>ISTE NETS - S</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 2: Design and Develop</td>
<td>Use of digital media</td>
<td>Standard 3: Research and Information Fluency</td>
<td>Student use of technology</td>
</tr>
<tr>
<td>Digital-Age Learning Experiences</td>
<td>including:</td>
<td></td>
<td>including:</td>
</tr>
<tr>
<td>and Assessments</td>
<td>• Videos</td>
<td></td>
<td>• SMART Board</td>
</tr>
<tr>
<td></td>
<td>• Images</td>
<td></td>
<td>• Websites</td>
</tr>
<tr>
<td></td>
<td>• SMART Board</td>
<td></td>
<td>• Geometer’s Sketchpad</td>
</tr>
<tr>
<td>Standard 3: Model Digital-Age Work</td>
<td>Modeled Technology and used</td>
<td>Standard 4: Critical Thinking,</td>
<td>Student use of technology</td>
</tr>
<tr>
<td>and Learning</td>
<td>digital tools such as:</td>
<td>Problem Solving, and Decision</td>
<td>to create lessons presented in</td>
</tr>
<tr>
<td></td>
<td>• SMART Notebook</td>
<td>Making</td>
<td>the class</td>
</tr>
<tr>
<td></td>
<td>• SMART Boar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard 5: Digital Citizenship</td>
<td></td>
<td>Standard 6: Technology Operations</td>
<td>Student use of technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and Concepts</td>
<td>in the design and development of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>lessons</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The EDIS 5320 course was observed using the Integration of Technology Observation instrument to measure the actual use of technology in the classroom. Most of the technology use
was the presentation of the lectures, modeling technology by the instructor, and modeling how a SMART board can be applied to the math topic being covered. Technology use and modeling of the use of a SMART board occurred primarily by the course instructor. There was minimal technology use by the students in this class and occurred primarily through the use of their own personal computers for note-taking purposes. Additional student technology use occurred through student participation and use of the SMART board when the instructor had students solve a problem on the board. Data collected on observed technology use for each of the ISTE NETS Standards is displayed in Table 8.

Table 8

<table>
<thead>
<tr>
<th>ISTE NETS - T</th>
<th>Evidence</th>
<th>ISTE NETS - S</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 2: Design and Develop Digital-Age Learning Experiences and Assessments</td>
<td>Use of digital media including: • SMART Board</td>
<td>Standard 3: Research and Information Fluency</td>
<td>Student use of technology including: • SMART Board</td>
</tr>
<tr>
<td>Standard 3: Model Digital-Age Work and Learning</td>
<td>Modeled technology and used digital tools such as: • SMART Notebook • SMART Board</td>
<td>Standard 4: Critical Thinking, Problem Solving, and Decision Making</td>
<td>Student use of technology to create lessons used in their field experiences</td>
</tr>
<tr>
<td>Standard 5: Digital Citizenship</td>
<td></td>
<td>Standard was not addressed during time of observation</td>
<td></td>
</tr>
<tr>
<td>Standard 6: Technology Operations and Concepts</td>
<td></td>
<td>Student use of technology in for the solution of problems presented in class</td>
<td></td>
</tr>
</tbody>
</table>

*Science Technological Pedagogical Knowledge*

The EDIS 5051 course was observed using the Integration of Technology Observation instrument to measure the actual use of technology in the classroom. Most of the technology use
was for presentation of lectures and modeling of SMART board use for presentation. Some of the presentation time was used modeling simulation software related to the topic being discussed. In this case the instructor used the SMART board as a projection screen and demonstrated a space simulation website to the class. Student technology use was limited to the students working on their own personal laptop computers. Data collected on observed technology use for each of the ISTE NETS Standards is displayed in Table 9.

Table 9

<table>
<thead>
<tr>
<th>ISTE NETS - T Evidence</th>
<th>ISTE NETS - S Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 2: Design and Develop Digital-Age Learning Experiences and Assessments</td>
<td>Use of digital media including: ● SMART Board</td>
</tr>
<tr>
<td>Standard 3: Modeled Technology and used digital tools such as: ● SMART Board</td>
<td>Standard 4: Critical Thinking, Problem Solving, and Decision Making</td>
</tr>
</tbody>
</table>

Findings and Data Analysis Using the Syllabi Evaluation Checklist

The Integration of Technology Observation Instrument was used to measure the amount of technology use by both the teacher and students in the class. This instrument is aligned with the ISTE NETS for Teachers standards two and three. The instrument is also aligned with the ISTE NETS for Students standards three, four, five, and six. Analysis of the data resulted in
evidence supporting that all observed courses addressed ISTE NETS – T standards two for use of technology in the classroom and standard three for modeling of technology. Analysis of the data resulted in evidence of the ISTE NETS – S standards being addressed in the courses observed as a part of this study. Analysis of the data resulted in evidence that the technology courses EDIS 3450 and EDIS 5440 addressed ISTE NETS – S standards three, four, five, and six. However analysis of the data showed content courses observed using this instrument did not address some of the ISTE NETS – S standards during the time of the observation.

*Syllabi Evaluation Checklist Data Analysis and Findings*

The Syllabi Evaluation Checklist was used to analyze course syllabi in order to assess the alignment of the courses’ activities with the following ISTE National Educational Technology Standards:

- **Standard Two: Design and Develop Digital-Age Learning Experiences** - looks at a teachers’ ability to use technology to design and develop learning experiences for their students

- **Standard Three: Model Digital-Age Work and Learning** - teachers demonstrate knowledge and skills as well as the ability to model and facilitate use of in technology for communication and collaboration using digital media and formats

- **Standard Four: Promote and Model Digital Citizenship and Responsibility** - teachers instill knowledge of the ethical use of digital information, proper decorum and responsibility when engaging in online social interactions, and promoting cultural understanding when using digital communications

A comparison of the results of the Syllabi Evaluation Checklist was run for all of the courses in which syllabi were obtained. The results of the data analysis show that all of the
syllabi that were evaluated showed evidence of addressing the National Education Technology Standards (NETS) for Teachers (Appendix F) numbers two, three, and four. Table 10 displays the findings of the syllabi evaluation.

Table 10

*Syllabi Evaluation Checklist Data*

<table>
<thead>
<tr>
<th>Course</th>
<th>Instructor</th>
<th>NETS-T #2 Addressed</th>
<th>NETS-T #3 Addressed</th>
<th>NETS-T #4 Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDIS 3450</td>
<td>Participant 8</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>EDIS 3450</td>
<td>Participant 9</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>EDIS 3450</td>
<td>Participant 10</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>EDIS 5440</td>
<td>Participant 11</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>EDIS 5450</td>
<td>Participant 3</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>EDIS 5320</td>
<td>Participant 4</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Findings and Data Analysis Using the Integration of Technology Observation Instrument

The Integration of Technology Observation Instrument was used to measure technology use in three minute intervals. Technology usage was assessed based on the National Education Technology Standards specifically focusing on: standards two, design and develop digital-age learning experiences, standard three, model digital-age work and learning, and standard four, promote and model digital citizenship and responsibility.

*Elementary and Special Education Technological Content Knowledge*

The data in Table 11 show the evidence gathered using the Integration of Technology Observation instrument as to how the EDIS 3450 course for elementary and special education students addresses the NETS-S standards two, three, and four.
Table 11
**EDIS 3450 Technical Content Knowledge (Elementary and Special Education)**

<table>
<thead>
<tr>
<th>NETS-S</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 2</td>
<td>Introduces various digital tools such as blogs, wikis, and various other tools that present and use digital media</td>
</tr>
<tr>
<td></td>
<td>Models use of digital tools introduced, asks students to write lesson plans enriched by one of the digital tools</td>
</tr>
<tr>
<td>Standard 3</td>
<td>Models and uses digital tools introduced in course</td>
</tr>
<tr>
<td>Standard 4</td>
<td>Covered copyright and fair use laws</td>
</tr>
</tbody>
</table>

The EDIS 3450 course for elementary and special education students addressed various digital tools such as blogs, wikis, and other tools that present and use digital media. This course also modeled and used digital tools like Virsona, a website that creates virtual personas and Diorama Designer, a software program designed to create 2-D images or 3-D objects using a digital fabricator. The coursework also included covering copyright and fair use. The topic of copyright covers laws pertaining to both the citation of material well as intellectual property. The topic of fair use covers how information can be used as long as it is transformative and does not compete with the original use of the information.

**English and Social Studies Technological Content Knowledge**

The data in Table 12 shows the evidence gathered using the Integration of Technology Observation instrument as to how the EDIS 3450 course for secondary English, language arts, and social studies students addresses the NETS-S standards two, three, and four.


**Table 12**

*EDIS 3450 Technical Content Knowledge (Secondary English, Language Arts, and Social Studies Students)*

<table>
<thead>
<tr>
<th>NETS-S</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 2</td>
<td>Addresses various digital tools that were related to English content and writing such as blogs, the use of video, and embedding video</td>
</tr>
<tr>
<td>Standard 3</td>
<td>Models and uses digital tools within the course</td>
</tr>
<tr>
<td></td>
<td>Final project of writing a technology rich lesson plan</td>
</tr>
<tr>
<td>Standard 4</td>
<td>Covers topics of copyright and dangers of video use in the classroom</td>
</tr>
</tbody>
</table>

The EDIS 3450 course for secondary English, language arts and social studies students addressed various digital tools that were related to English content and writing such as blogs, the use of video, embedding video, and modeling and use the use of a SMART board. There was also evidence of coursework addressing copyright and dangers of video use in the classroom, or using YouTube in the classroom.

*Math and Science Technological Content Knowledge*

The data in Table 13 show the evidence gathered using the Integration of Technology Observation instrument as to how the EDIS 3450 course for mathematics and science students addresses the NETS-S standards two, three, and four.
EDIS 3450 for mathematics and science students addressed the TPACK model (Mishra & Koehler, 2006) with an introduction to TPACK along with covering copyright and fair use in the first week of class. The course addresses the use of various digital tools such as social networking, digital images, digital fabrication, and online collaboration tools. The course also addressed using digital tools for assessment, assessment of digital tools and websites, and creating websites.

The data in Table 14 show the evidence gathered using the Integration of Technology Observation instrument as to how the EDIS 5440 course addresses the NETS-S standards two, three, and four.
EDIS 5440 is the other technology specific course offered at Middle America University. This course is guided by the TPACK model (Mishra & Koehler, 2006) and addresses various digital tools such as YouTube, TeacherTube, and other sources of video media. Modeling and use of technology was demonstrated first by following along with the lecture by students viewing the presentation on their computers and by submitting questions via email to the instructor during the lecture. The coursework also addressed fair use and copyright laws when using video and pictures from the Internet.

English and Social Studies Technological Pedagogical Knowledge

Prior to data collection, the faculty teaching methods courses in English, language arts, and social studies were contacted in order to gain access to course syllabi for document analysis. Permission was not obtained nor were any syllabi provided for any English, language arts, or social studies content methods courses.

Math Technological Pedagogical Knowledge

The data in Table 15 shows the evidence gathered using the Integration of Technology Observation instrument as to how the EDIS 5450 course addresses the NETS-S standards two, three, and four.
Table 15

**EDIS 5450 (Mathematics for Secondary Schools II)**

<table>
<thead>
<tr>
<th>NETS-S</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 2</td>
<td>Use of various digital tools, online applets, and graphing calculators</td>
</tr>
<tr>
<td>Standard 3</td>
<td>Models and use of digital technology for presentation of student taught lessons</td>
</tr>
<tr>
<td>Standard 4</td>
<td>No evidence within the course syllabi</td>
</tr>
</tbody>
</table>

EDIS 5450 is designed to allow students to explore the use of technologies that can be used to enhance the teaching and learning of math. The course addresses various digital tools such as Geometer’s Sketchpad, online applets, and graphing calculators. The students give and receive modeling and use of digital technology through the teaching of lessons in class and observations during their field experience. There was no evidence within the course syllabi that addressed NETS-S four.

The data in Table 16 shows the evidence gathered using the Integration of Technology Observation instrument as to how the EDIS 5320 course addresses the NETS-S standards two, three, and four.
Table 16

**EDIS 5320 (Mathematics in Elementary Schools)**

<table>
<thead>
<tr>
<th>NETS-S</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 2</td>
<td>Student technology use of the SMART Notebook, digital fabrication, and technology manipulatives</td>
</tr>
<tr>
<td>Standard 3</td>
<td>Model and use of digital technology specifically the SMART Notebook software.</td>
</tr>
<tr>
<td>Standard 4</td>
<td>No evidence within the course syllabi</td>
</tr>
</tbody>
</table>

EDIS 5320 has built in course competencies listed within the syllabi for using technology effectively within the math classroom. The course is designed so that students have opportunities to use technology such as the SMART Notebook, digital fabrication, and technology manipulatives. The course is also designed so that students gain practical experience modeling and using digital technology through student presentations of lessons created using the SMART Notebook software. There was no evidence within the course syllabi that addressed NETS-S four.

**Science Technological Pedagogical Knowledge**

Prior to data collection, the faculty teaching the science methods courses were contacted in order to gain access to course syllabi for document analysis. A syllabus was requested for the course EDIS 5051, Teaching Science in Secondary Schools II. However, no syllabus was made available for analysis using the Syllabi Evaluation Checklist.

Data from the Syllabi Evaluation Checklist

The Syllabi Evaluation Checklist was used to analyze course syllabi in order to assess the alignment of the courses’ activities with the following ISTE National Educational Technology
Standards for Teachers: standard two, design and develop digital-age learning experiences; standard three, model digital-age work and learning; and standard four, promote and model digital citizenship and responsibility. Analysis of the data showed evidence that all courses that submitted a syllabus addressed ISTE NETS–T standards two, three, and four in their lectures, coursework, and assignments.

The Snapshot Assessment Instrument

The Snapshot Assessment Instrument includes categories based on the International Society for Technology in Education National Educational Technology Standards. This instrument was used to gather data on how technology is being used, to gain information about the program’s access to technology, and to determine if the MAU Program had the necessary elements to implement National Education Standards.

The elementary and secondary pre-service preparation programs share the same building facilities. The Snapshot Assessment Instrument was used to assess the technology infrastructure of the building. The MAU Program has five fully equipped classrooms and two computer labs. The MAU Program currently has a technology infrastructure in place so that each classroom is equipped with Internet access, a desktop computer, projector, and audio capability. One of the classrooms, Miller Hall Room 218A, is a fully equipped science lab. The Lab also houses nine desktop computers located at each of the lab stations and is equipped with probe hardware and software for the computers. There is also Wi-Fi Internet access throughout the building. Several methods course were held within the two computer labs at the MAU Program as well as the Teaching with Technology and Applied Teaching with Technology courses. Room 209 houses the largest computer lab. The technology in this room consists of twenty desktop computers, a projector and SMART board setup, and a printer. The second computer lab was housed in room
This lab was equipped with seven desktop computers, a projector and SMART board setup, a printer, and several digital fabricators. The MAU Program is currently undergoing building renovations. One question posed to participant 2 by the researcher asked whether there was going to be an addition to the number of computer labs or computers in the labs at the MAU Program. The response from Participant 2 was: “now 90 to 95 percent of the students who are coming in to the teacher preparation program have a laptop so now hardware is not the issue…today the software is the issue.” The MAU Program only boasts two moderate sized labs. The focus on computer hardware has moved to hardware that the average computer user does not have. Currently there is a focus on the Children’s Engineering Initiative, thus the focus in the computer labs is 2-D and 3-D fabricators and other technology that the average student is not likely to own.

University Collaboration

Faculty collaboration occurs through cross-content and cross-departmental committees, meetings, and projects. The first cross-departmental committee was created during the redesign of the pre-service preparation program in the mid 1980’s with the formation of the Educational Technology Committee. This committee was a group composed of a representative from each department in order to oversee the school’s overall technological direction (Wootten, 1998). Cross-content faculty meetings also occur for the secondary and elementary programs. Finally, projects such as the Children’s Engineering Initiative have been developed.

There are two methods of collaboration that emerged from the data gathered from the MAU Teacher Preparation Program. The first method of university collaboration emerged with the graduate instructors assigned to teach the EDIS 3450 courses. These instructors collaborate with faculty in order to establish a connection with the instructional technology program,
working with the faculty to develop methods of integrating technology in the methods course.

The second method of university collaboration emerged from the collaborative effort surrounding the Children’s Engineering Initiative project.

Faculty and Instructor Collaboration

During the formal interviews, the topic of collaboration between instructors of the EDIS 3450 courses and the faculty who teach the content methods courses emerged in all three of the EDIS 3450 discipline areas. In the discipline area of elementary and special education, participant 10 mentioned how their activities are guided by the content area professors to ensure that the pre-service teachers have the knowledge necessary to help them succeed once they enter the field as professionals. In the discipline area of English and social studies, participant 8 discussed in their interview the contact with faculty of the content area course. In the same respect in their interview, participant 12 discussed how participant 8 allowed students from their class to work on assignments from their class so that those assignments could benefit from the enrichment of content specific technology. Finally in the discipline of math and science, participant 9 collaborated with the math and science teachers prior to the development of their EDIS 3450 class. In addition to that collaboration, participant 9 also sat in on the science methods course, which established an additional connection between the methods course and the teaching with technology course.

Children’s Engineering Initiative

The MAU Teacher Preparation Program has been noted for its culture of the collegiality through their shared projects, meetings, and teaching endeavors. There is evidence of cooperative relationships among faculty members. According to Participant 2, “Participant 5 and Participant 6 have a very positive relationship with shared values and shared desire to advance
things.” Participant 4 stated, “I think that for the most part we learned that we liked each other. We get along. I don’t think that can be understated for a program to have success. We all have our quirks, but we all truly get along professionally and personally.” This culture of collegiality is displayed through its faculty collaboration efforts.

The Children’s Engineering Initiative is a project with the goal of encouraging science, technology, engineering and math (STEM) into elementary education. The goal of the initiative is to develop project-based lessons that can be used in elementary classrooms to promote and develop problem solving and analytical skills in the STEM disciplines (Rector and Visitors, 2011b). Participant 2, who is the head of the Children’s Engineering Initiative, discussed how projects that are developed through the Children’s Engineering Initiative are field tested at the local school district then disseminated both through publication and via national and international conferences. Faculty members associated with the initiative include participant 2, participant 3, participant 4, participant 6, participant 8, participant 9, participant 11, and participant 13.

Summary of Data Findings

A qualitative research study was conducted using a case study methodology in order to determine how an exemplary teacher preparation program prepares its teachers to be technology literate. The research questions guiding this study looked at how the program ensures technology literacy of pre-service teachers. Data for this study was gathered from interviews, observations, and document analysis. The data gathered was reviewed using the TPACK framework and compared to how the program achieved the National Education Technology Standards. Analysis and interpretations of the data are explained further in chapter V.
Chapter 5 Conclusions and Recommendations

This study was guided by three research questions: 1) How does the institution’s teacher preparation program ensure that pre-service teachers are technologically literate? 2) How does the institution evaluate its pre-service teachers’ to ensure that they have met the technology literacy standards?; and 3) How does the institution evaluate their teacher preparation programs to ensure that pre-service teachers are technology proficient? The first section of this chapter details the results of how the MAU Teacher Preparation Program prepares pre-service teachers to be technology literate. The next sections discuss how the program evaluates technology literacy in its pre-service teachers and how the teacher preparation program is evaluated.

Technological Pedagogical Content Knowledge

Technological Pedagogical Content Knowledge is the complex interplay of the three domains of technology, pedagogy, and content (TPACK). Furthermore, one who has an understanding of TPACK is able to achieve technology integration by developing curricular units that use technology to enrich and enhance the curriculum through selection of technology appropriate for the content and through pedagogical skills seamlessly integrating the technology into the unit of instruction. The MAU Teacher Preparation Program utilizes the TPACK framework as their model of technology integration and uses it as part of the curriculum within their teaching with technology courses. The MAU Program’s method of providing TPACK to their pre-service teachers is through technology integration throughout the teacher preparation program, hands-on technology use, and modeling by faculty. The concepts of TPACK are expressly taught within the technology coursework and applied within the content method coursework. Finally, these skills are put into practice through coursework scenarios and projects.
as well as through field experiences. The MAU Program’s philosophy of technology integration includes multiple experiences of technology throughout the teacher preparation program including requirements and use of technology in the field experiences and follows the research on technology training for pre-service teachers (Dawson & Nonis, 2000; Falba et al., 1999; Niess, 2001; O’Bannon et al., 1998; Strudler & Grove, 2002).

*Sustaining TPACK in a Fluctuating Team Dynamic*

Within the MAU Teacher Preparation Program, the teacher preparation program works with a team of constantly changing members. The students within the program take their content area coursework within the colleges of their majors. The teaching with technology courses are taught by graduate instructors, who by their very nature are instructors in the teacher preparation programs for a limited time. The content methods courses are taught by tenured or tenure-track faculty. While a change in faculty members is not a common occurrence, changes in faculty can and do occur. This research study focused on the technology and content methods courses within the MAU Teacher Preparation Program.

**Technology Courses**

The teaching with technology courses are taught by graduate instructors in the instructional technology program and are overseen by participant 2. The teaching technology course is divided by content area and each of the graduate instructors teaching a class has a background that matches the content area. For example, participant 9 has a background in English so they teach the section dedicated to English, social studies, and foreign language. Participant 10 has a degree in engineering so they teach the section in science and math. Participant 8 is the newest of the graduate instructors. When asked how they designed the curriculum for their course, they stated that they worked with participant 2, content methods
faculty, and the other graduate instructors to design and develop the course. It can be
conjectured that the MAU Program deals with this changing population through selecting new
graduate instructors based on their content area backgrounds, through guidance from participant
2 and the content methods professors they work with, and through mentoring by the veteran
graduate instructors in the program.

Content Methods Courses

The faculty who teach the content methods courses are either tenured or tenure-track
faculty. Despite their reputation for technology integration, Participant 2 notes that not all
faculty members are equally invested in technology integration. However, there is a core group
of faculty, which makes a nucleus for the community that interacts and works together to
promote technology integration. Participant 2 discussed how in order to promote technology
integration, “you just need a critical mass enough have a dialogue… so the best you can do is
recruit new faculty and then hold on until you can build up a critical mass of them.

The MAU Teacher Preparation Program actively recruits faculty and staff that have a shared
mission and research agenda of technology integration. When recruiting new faculty, the search
committee actively seeks potential faculty members who are both leaders in their respective
content area fields and sustain a line of research on technology integration within that field.
Participant 2 discussed how faculty like participant 6 was just hired to work in science education:
“Our focus and our searches like for participant 5 was brought in here specifically as someone
who integrates science education with technology. We specifically brought in a professor here to
integrate leadership and technology integration … they were brought here from a specific job
search for that purpose.”
This faculty hiring policies has helped to continue the culture of technology integration through the recruitment of faculty who share a research interest of technology in education. This shared interest fosters the development of the collegiality and collaborative efforts observed by the researcher.

Technological Content Knowledge

Technological Content Knowledge (TCK) is an understanding of the how technology is affected by the content and how it can be driven by content. The MAU Teacher Preparation Program addresses the domain of TCK to their pre-service teachers via the EDIS 3450 course. The course is unique in that each section of it is differentiated by discipline so that the students receive technology skills and knowledge directly related to the content area that they are going to teach.

The EDIS 3450 course is also unique in that there is no common or set curriculum. Each course section establishes its own curriculum based on guidance from faculty, peers, and the current interests and projects of the students enrolled in the course. The notion of using a set curriculum or text was disregarded due to the rapid changes in technology and technology use in the school system. The only commonality within the curriculum is that all sections contain units teaching the principals of TPACK. One benefit of having a fluid curriculum is the ability to adapt the curriculum to cover topics of interest and to work with technology that directly applies to the students’ lessons and field experiences.

During the document analysis portion of the study syllabi were evaluated to determine if they address National Education Technology Standards for Teachers (NETS-T). The literature review showed that currently the International Society for Technology in Education (ISTE) NETS-T are recognized by most professional organizations and accreditation agencies as the
standards to use for determining technology literacy. The course goals were documented but the standards tied to the goals were not clearly addressed on the syllabi. One suggestion is that all syllabi include the standards they are addressing, technology or content area, be clearly noted within their own section of the syllabi.

Technological Pedagogical Knowledge

Technological Pedagogical Knowledge (TPK) is the ability to understand how to teach with technology. TPK is more than understanding how to teach a lesson using a certain piece of technology. TPK is having the knowledge of the various technological tools and resources so that once a lesson has been designed technology can be added to enhance and enrich the lesson. The MAU Teacher Preparation Program addresses TPK through the content methods courses. The focus in the content methods courses is never technology. In fact there is no evidence of any standards being used other than the national standards of the course’s particular content area. Instead TPK is achieved through the addition of technology after the topic has been discussed, so that students are first learning the content and then learning how to enrich the teaching with technology.

Personality Driven Curriculum

The redesign of the teacher preparation program in 1984 was spearheaded by the then Dean of the MAU Teacher Preparation Program. The focus of technology integration within the MAU Teacher Preparation Program has remained a constant despite changes in leadership. One aspect that has not changed within the MAU Teacher Preparation Program is the leadership in the area of technology provided by participant 2.

Participant 2 is a professor of instructional technology, co-director of the Center for Technology and Teacher Education (CTTE), and a member of various professional organizations
working with education technology. Participant 2 has been acknowledged by their peers for their “ethic of technology integration and that instructional goals drive the use of technology” and was noted by the researcher as the one constant in regards to technology integration in this study.

The MAU Teacher Preparation Program is a small program with a small faculty in a larger university that has gained its reputation through it education programs. Participants of this study had direct connections with participant 2 through the Children’s Engineering Initiative and the MAU Center for Technology and Teacher Education. Even the faculty who were not participants of this study has known connections with participant 2 either as part of the Children’s Engineering Imitative, the Center for Technology and Teacher Education, or through their input in the new faculty hiring process. One conjuncture made by the researcher is that though there have been several changes in the position of Dean at the MAU Teacher Preparation Program, the technology leadership has remained constant over the past thirty years. Participant 2 is a driving force for the technology integration within the MAU Program. One question that has resulted from this research is how the eventual retirement of participant 2, who provides steady leadership and continually strives for instructional technology integration, will impact the MAU Program. Will that void cause technology integration to degrade? Will the culture of technology integration be sustained?

Faculty Collaboration

During the data analysis, one theme that emerged was collaboration within the different content areas across teacher preparation programs. This was particularly evident in the STEM group. The culture of the MAU Teacher Preparation Program supports and promotes technology integration through collaboration of this core group of faculty and graduate instructors through projects such as the Children’s Engineering Initiative.
During the interview process the topics of technology projects and relationships with peers inevitably appeared. When discussing projects and peers there was an air of open collegiality expressed by the faculty at the MAU Teacher Preparation Program. During the interviews all faculty discussed projects in which they openly sought the opinions of others and discussed how they worked well with their peers on a personal and professional level. Evidence of collegiality was apparent to the researcher during the research study.

In chapter four the collaborative efforts of the MAU Teacher Preparation Program were discussed. One unique collaborative effort noted by the researcher was the Children’s Engineering Initiative. On paper the initiative appears to be the collaborative effort of faculty in the areas of math, science, and technology. However, the Children’s Engineering Initiative is actually comprised of representatives from elementary and secondary math, science, reading, and technology faculty in addition to the graduate students associated with the various teaching with technology courses. The Children’s Engineering Initiative was not known to the researcher prior to arriving at the Middle America University to conduct the study. The group held one meeting during the time of this study. The researcher noted the interactions of the group gave an air of familiarity, and the tone and mood of the meeting gave the appearance of group dynamics showing a good working relationship of the participants. The other observation noted by the researcher is that all of the interview participants at the time of the study were members of the Children’s Engineering Initiative and present at the meeting.
Assessment of Technology Literacy

At the time of this study there was no official method of assessment used to ascertain if per-service teachers had met technology standards designated by the MAU Teacher Preparation Program. There is evidence that technology literacy is assessed within individual courses. Technology literacy assessment varies depending on the faculty member and can range from questions on summative and formative assessments to information gleaned from rubrics used to assess student projects. There is no evidence of common assessments, shared rubrics, or documentation showing the technology literacy standards targeted in assessments.

A balanced assessment system consists of assessments at the classroom level, program level, and institutional level (Stiggins, 2006). Technology literacy should also be assessed formatively throughout the program at the classroom level to be used as a tool in the design of instruction to meet the needs of the students. Assessment at the program level would involve the teacher preparation program creating common assessments to aid in the evaluation of technology literacy for students in their coursework and in the evaluation of the department’s ability to ensure technology literacy. Common assessments could be used formatively to help faculty determine areas that need further instruction and to assess how students are progressing compared to their peers in other courses. In this case, the school serves as the institutional level. There should be a summative technology assessment that would be used to assist in monitoring growth and to evaluate student mastery of educational technology standards.

Evaluation of Teacher Preparation Program

At the time of this study there was no official method of assessment used to ascertain that the pre-service teachers graduating from the MAU Teacher Preparation Program were technologically proficient. During data collection it was reported that there have been several
dissertations and graduate studies on the technology proficiency of students in the MAU Teacher Preparation Program’s teacher preparation program. At the time of this study there was no evidence that any of these studies were used by the MAU Teacher Preparation Program to influence policy or procedures. These sources of information were not used in this study due to the fact that they focused on students from individual content area programs rather than a holistic look at the program itself. A recommendation is that students should be assessed prior to the beginning of the program in order to determine the student’s technology strengths and weaknesses.

Analysis of Research Questions

This study reviewed an exemplary teacher preparation program through faculty interviews, classroom and building observations, and document analysis to determine if this institution produces technology literate pre-service teachers by answering the following research questions:

1) How does the institution’s teacher preparation program ensure that pre-service teachers are technologically literate?

The Integration of Technology Observation Instrument and the Snapshot Assessment Instrument were used to assess technology integration and technology use modeled by faculty. The Syllabi Evaluation Checklist was used to assess how both the technology and content area courses address the ISTE National Education Technology Standards through course work.

The teacher preparation program acknowledges the TPACK framework as their model of technology integration. The teacher preparation program provided their pre-service teachers with technology integration throughout the teacher preparation program via technology use
modeled by faculty. TCK was developed within the technology coursework, the content method coursework, and through the application and practice of TPACK within the overall coursework and through field experiences.

2) How does the institution evaluate its pre-service teachers’ to ensure that they have met the technology literacy standards?

To determine how the institution evaluated its pre-service teachers’, data were collected as part of the participant interviews and through document analysis. Participants interviewed in this study included the Director of Teacher Education, faculty, and graduate instructors. Documents requested for data collection included the institution’s accreditation report, institutional evaluation data from their pre-service teachers, and course syllabi. The only documents released for use of this study were course syllabi.

At the time of this study there was no official method of assessment used to ascertain if pre-service teachers have met technology standards designated by the teacher preparation program. There is evidence that technology literacy is assessed within individual courses. Technology literacy assessment varies depending on the faculty member and can range from questions on summative and formative assessments to information gleaned from rubrics based on student projects and assessments. There is no evidence of common assessments, shared rubrics, or assessments showing which literacy standards assessments targeted.

3) How does the institution evaluate their teacher preparation programs to ensure that pre-service teachers are technology proficient?

As noted in question two there is no official method of assessment used to ascertain that the pre-service teachers graduating from the teacher preparation program were technology proficient
proficient. During data collection it was reported that there have been several dissertations and graduate studies on the technology proficiency of students in the teacher preparation program. However, these sources of information were not used in this study due to the fact that they focused on students from individual content area programs rather than a holistic look at the program itself.

The data gathered from the interviews, observations, and course syllabi provides evidence for providing technology integration and use within the teacher preparation program. The data also provides evidence that the ISTE National Educational Technology Standards were addressed in coursework in both technology and content area courses. However, no data collected providing evidence that MAU Teacher Preparation Program formally assessed their pre-service teacher’s technology literacy. Also there was no evidence of a formal assessment by the University to ensure that the Teacher Preparation Program was ensuring technology literacy. Based upon the results of this study and a review of the literature in pre-service teacher preparation for technology literacy a Revised/Adapted Model of Technology Literacy is proposed.

A Revised Model of Technology Literacy

Mishra and Koehler’s (2006) TPACK framework was developed to guide the knowledge needed for effective technology integration through an understanding of the relationships between the domains of technology, pedagogy, and content. The TPACK framework was designed to be used as a framework for technology integration; however, a model for technology integration in teacher preparation programs has not been developed due to the many variations in programs. Because each teacher preparation program is different and there are multiple methods of developing TPACK, there is no definitive research that provides evidence of one perfect
The research in this study builds upon Mishra and Koehler’s (2006) TPACK framework. The model suggested in this study is not intended to be a recommendation for the one true model of technology integration. Instead this model combines research on technology integration and current practices of an exemplary teacher preparation program in order to create a new model for technology integration in teacher preparation programs.

The proposed model builds upon Mishra and Koehler’s (2006) TPACK framework. Mishra and Koehler (2006) suggest the importance of studying the interaction between the paired domains of TCK and TPK prior to taking a holistic view of the entire TPACK framework. This revised/adapted model suggests components for teacher preparation programs including TCK, TPK, and a new domain of technology experiences before addressing the entire TPACK framework.

Complementary Courses

The concept of TCK may be emphasized in both content specific and technology coursework. Technology and content area courses should complement one another so that pre-service teachers can learn technology specific to their content area in one course and learn the pedagogical skills to effectively apply the technology to enhance student learning in another course. The next section of the proposed model goes into further detail concerning how these two concepts complement each other.

Technological Content Knowledge

Technological Content Knowledge can be developed within but is not limited to the technology course. Different content areas require and use different types of technology. The technology course should be content or area specific to ensure that students are focusing on developing TCK for the content area they are going to teach. This course should focus on
technology, however, it should not focus on teaching how to build a website or how to use a specific set of programs. Instead the focus of this course should be how pre-service teachers learn to find technology and assess the suitability of that technology for the enrichment of units of instruction in particular content areas. Pre-service teachers who are majoring in elementary or special education should also have their own technology course that is specific to the needs of teachers who will be teaching multiple content areas.

The technology course should be taken during the same term as the content methods course. Collaboration between the technology course instructors and the content methods instructors needs to occur with course assignments and projects. This ensures that the pre-service teachers are gaining hands-on experience in technology integration by enriching the lessons they are generating in their content methods course. The research found as part of the review of literature states that a single technology course is not sufficient in developing technology literacy, and the technology course should be linked to the methods course. Based on the research, in order to develop technology literacy in pre-service teachers multiple exposures to technology are needed. This can be accomplished by pairing a technology course with each content methods course or through the addition of a technology lab to every content methods course. Either method would provide pre-service teachers with the necessary exposure to technology by having more than one technology course.

For teacher preparation programs unable to offer multiple sections of their technology course or who are unable to differentiate the technology course by content area there are alternative recommendations. One recommendation is that the technology course be designed so that it addresses the technology literacy standards. Then coursework should be differentiated for students so that through collaboration with the content area classes the coursework will address
technology relevant to the student’s content area. A second recommendation is that a one credit lab is attached to the content methods course. This lab will allow students to work on their TCK by working on assignments and projects related to their content area with time dedicated to enhancing and enriching their lessons with technology.

Technological Pedagogical Knowledge

Technological Pedagogical Knowledge can also be developed within, but is not limited to the content methods courses. These courses should not focus on technology. Instead content methods courses should focus on developing the pedagogical skills necessary to teach their content areas. Once a particular unit has been mastered, pre-service teachers will work on enriching the unit with technology.

Collaboration between the content methods course and the technology course was mentioned in the previous section. Coursework in the content methods course will focus primarily on developing PCK. However, at the end of each unit the course should then focus on how technology can be brought into the unit of instruction to enrich and enhance the unit that develops TPK. Pre-service teachers will continue to develop TPK further by developing the technology components to their units of instruction within the technology course.

Technology Experiences

For technology integration to occur technology knowledge cannot solely occur through a single technology course. Technology knowledge should occur in a technology course, via faculty modeling technology integration, and with student projects to enrich lessons with technology throughout the teacher preparation program. In order to achieve technology literacy, technology integration must occur throughout the program with technology use being modeled by the faculty within their own instruction with the integration strategies intentionally discussed
with pre-service teachers. These future teachers must use technology to develop and present their coursework assignments and projects.

In preparing pre-service teachers to be technology literate, technology integration must occur throughout the entire program providing opportunities for multiple exposures to technology. Exposure to technology integration and use needs an active component within the field experiences that should occur throughout the program. It is especially important for field experiences to occur at the same time as the complementary content methods courses and technology courses. These field experiences should provide opportunities for pre-service teachers to gain practical experience teaching instructional units enriched with technology. These experiences will give pre-service teachers opportunities to teach the units they design in their content methods courses and to field test the technology they developed and incorporated into their lesson plans during their technology course. Pre-service teachers will also gain valuable lessons in technology integration such as working with district information technology staff, planning ahead in requesting and checking out equipment, and developing alternate plans in case the technology does not work.

*Technological Pedagogical Content Knowledge*

Developing Technological Pedagogical Content Knowledge in pre-service teachers is more than teaching the relationship of the knowledge domains of technology, pedagogy, and content. In order to prepare pre-service teachers to integrate technology in their classrooms, technology integration should occur throughout the teacher preparation program. In order to address technology integration in the teacher preparation program a fourth component was added to the TPACK framework, technology experiences. The technology experiences component addresses the point that technology integration needs to be infused throughout the teacher
preparation program including the field experiences. Technology should be modeled and explained by faculty within their own instruction, and pre-service teachers should be required to use technology as a part of their coursework and projects. The goal of this revised/adapted model is to use the TPACK framework to promote technology literacy in pre-service teachers who have the skills to seamlessly integrate the technology into units of instruction. Through the use of this model, pre-service teachers should have the knowledge necessary to achieve technology integration through their ability to create curricular units that use technology to enrich and enhance the curriculum through the selection of technology appropriate for the content.

The MAU Teacher Preparation Program is a unique program. While elements of the program are common throughout all teacher preparation programs, there are many aspects of this program that are atypical of other programs. In many cases teacher preparation programs cannot differentiate their coursework between their elementary and secondary programs. Generally content area courses are not housed within the College of Education. For programs that are small and cannot differentiate coursework for elementary and secondary programs, the focus should be on technology integration to enrich and enhance lessons developed in the coursework. In some programs the secondary methods courses are not taught in the College of Education. Instead these courses are taught within the college of the content area. In cases such as this, there should be a focus on technology integration throughout the courses within the teacher preparation program. The development of TPK and TCK will have to occur within the pedagogy coursework and in technology courses taught in the College of Education.
Suggestions for Further Research

Many opportunities for future research exist. There is a gap in the research in the area of models of technology literacy in pre-service teacher preparation. The researcher recommends research both in future studies of the MAU Teacher Preparation Program as a model program and studies of other teacher preparation programs’ models of achieving technology literacy for students in their programs.

The case selection for this study was primarily based on Arthur Lavine’s research in *Educating School Teachers* (2006). This report listed four exemplary teacher preparation programs, one of which was use as the subject for this study. Future research in how exemplary teacher preparation programs prepare their teachers to be technology literate could be enhanced through a multi-case study of all four of these programs.

One of the findings of this study was that there is no formal assessment of technology literacy either at the class, department, or college level. The lack of a formal assessment of technology literacy makes it problematic to support the claims of technology literacy. Future research to support the claims of technology literacy within the MAU Teacher Preparation Program would be documented assessment of technology literacy built in the teaching with technology courses or an assessment of technology literacy prior to graduation.

During this study data were gathered to suggest that the culture at the MAU Teacher Preparation Program impacted the level of technology integration in the teacher preparation program. Further research into the culture at the MAU Program will provide additional insight into how technology integration occurs and how the culture of technology integration has been sustained over the course of the last three decades.
Finally, a revised/adapted model for developing technology literacy in pre-service teacher preparation programs was proposed earlier in this chapter. Each college and university is unique in its own intricacies and complexities, thus making a-one-size-fits-all model for technology literacy improbable. Additional research is needed to test the revised/adapted model in how it can be applied to different teacher preparation programs.

Summary and Conclusion

This qualitative single case study explored how an exemplary pre-service teacher preparation program prepares its students to be technology literate. The theoretical framework states that technology literacy can be achieved through developing the knowledge of the interplay of technology, content, and pedagogy in the process of designing instruction. The literature implies that teacher preparation programs need to have technology integration throughout the entire program as well as in the field experiences in order for pre-service teachers to achieve technology literacy. The results of this case study show that technology is integrated throughout the program and is guided by the theoretical model of TPACK. While methods of technology integration varied as to individual faculty, the underlying conclusion of the data in this research study is that the MAU Teacher Preparation Program uses the TPACK framework to prepare their pre-service teachers to effectively integrate and use technology.

The findings of this study further the research for institutions to use as a model for restructuring their teacher preparation programs. The model suggested is neither a magic bullet nor a blueprint designed to rebuild teacher preparation programs into the one perfect program of technology integration. Instead the model is intended to act as a guide with recommendations for the pieces necessary to promote technology literacy in pre-service teachers.


Appendix A
Consent Form

CONSENT FORM
Seeking Academic Excellence: Scholarship-Male Student Athletes’ Perceptions of Academic Support Programs at Division I Institutions

Researcher: Tracy N. Easter, Doctorate Candidate, Washington State University, (509) 680-4871

Date

Researchers Statement

My name is Tracy Easter, and I am a graduate student in the field of Higher Education Administration at Washington State University. I would like to request your participation in a study on technology literacy in teacher preparation programs. Please read carefully. You may have questions regarding the purpose of this study, your rights as a participant, and what I would ask of you. After answering all your questions, you can decide whether to participate in this study. I will also provide you a copy of this form for your records. This process is called informed consent.

Purpose

Recent research shows that teacher education programs are doing better at integrating technology, yet still pre-service teachers are not prepared to integrate technology into the classroom (Kleineret. al., 2007). In Educating School Teachers, Levine (2006) recognized this university as having an exemplary teacher preparation program. The purpose of the proposed study is to examine how this exemplary teacher education program prepares pre-service teachers to be technology literate upon graduation.

Procedures

An interview protocol has been developed for this study. Each participant will be asked to take part in an open ended interview that will follow the protocol. The protocol is meant to standardize the interviews, but the interviewer may ask follow-up questions related to the knowledge, and/or insight of the individuals. Each interview will last 45-60 minutes and will be recorded on audio tapes. All participants will be given an overview of the research project and the types of questions they will be asked prior to the actual interview.

Risks
The potential risk to participants in qualitative research is extremely low. In specific instances, a participant may experience emotional discomfort if the interview questions stir up emotional issues. You are free to not answer any questions you may find objectionable. It is important that you understand that your participation is completely voluntary. This means that even if you agree to participate you are free to withdraw from the study at any time, or decline to participate in any portion of the study, without penalty.

Other Information

Confidentiality will be strictly maintained. Only the researcher will have the only access to the audio tapes and transcriptions. Research materials will be kept up to three years at which time they will be destroyed.

Understand that if you have any questions or concerns regarding this project, you can contact the investigator at 509-680-4871 or teaster@wsu.edu and if you have any questions or concerns regarding your rights as a participant you can contact Washington State University’s Institutional Review Board at 509-335-9661 or irb@wsu.edu. Your participation in this matter is greatly appreciated and I look forward to working with you.

Thank you for your time.

Tracy N. Easter
Printed name of researcher                      Date                      Signature of researcher

Consent Statement

This study has been explained to me and has agreed to participate in this experiment. I understand that if I have any questions or concerns regarding this project I can contact the investigator or the WSU Institutional Review Board at 509-335-9661 or irb@wsu.edu. I will receive a copy of this consent form.

Printed name of subject                      Date                      Signature of subject
Appendix B
Interview Protocol

Project:
Time of Interview:
Date:
Place
Interviewer:
Interviewee:
Position of Interviewee:
Description of project

Individual (Approximately 45 min – 1 Hour)

1. What technology standards did your institution use to develop your program?
2. What course work do you feel prepares you student to be technology literate?
3. How do you integrate technology in the classroom?
4. How do you integrate technology in the field experiences?
5. How do you assess that you students are technology literate upon graduation?

Thanks for participation and assurance of confidentiality
### Appendix C

Syllabi Evaluation Checklist

<table>
<thead>
<tr>
<th>Name</th>
<th>Program</th>
<th>Area</th>
<th>Technology</th>
<th>Activity Using Technology</th>
<th>Assessment of Technology</th>
<th>Course Support (Goal I.A)</th>
<th>Professional Development (Goal III)</th>
<th>Student Implant (Goal III)</th>
<th>Distance Education (Goal III)</th>
<th>Other</th>
</tr>
</thead>
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<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
### 2. Teacher Role—What is the Teacher's Role?  
Nets+ I.I.B. III.C.

<table>
<thead>
<tr>
<th>SEGMENT</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directing (telling, lecturing) whole group</td>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>Interactive direction whole group</td>
<td>2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2</td>
</tr>
<tr>
<td>Modeling whole group</td>
<td>3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3</td>
</tr>
<tr>
<td>Facilitating/coaching</td>
<td>4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4</td>
</tr>
<tr>
<td>Managing behavior or materials</td>
<td>5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5</td>
</tr>
</tbody>
</table>

**NOTE.** Focus on the teacher who is the ASUW graduate, not on any other adult who happens to be present (e.g., aide, volunteer, another teacher).

**Protocol.** Mark all that apply.
1. Directing: Teacher directs learning and does most or all of the talking. Provides information or explanations. Controls topic and pace.
2. Interactive direction: Teacher directs learning and does most of the talking, but asks for students' responses. For example, may follow the IRE format (teacher initiates, students respond, teacher evaluates).
3. Modeling: Teacher demonstrates a skill or strategy. "Watch me do it" is the implied or spoken message. Aligned with instructional goals.
4. Facilitating/coaching: Students do most of the talking and work. This time IS aligned directly with instructional goals. Students interact with one another, materials, or problems and teacher asks questions or provides suggestions. Teacher is clarifying, engaging, or motivating one-on-one or with a small group.
5. Managing: Time is spent on managing class behavior. This is NOT time aligned with instructional goals. Teacher is managing behavior, materials, or solving computer problems in order to get students on task.

**Rationale.** PT³ teachers should have materials organized and students trained in management issues so that most class time is spent on activities relevant to learning objectives. Teacher role as director or coach should correspond to lesson goals. This item provides descriptive data of how teachers use class time. We hypothesize that second-year teachers will spend less time in management than first-year teachers.
## 3. Teacher Use of Technology

<table>
<thead>
<tr>
<th>NETS+T I.B.</th>
<th>II.D.</th>
<th>III.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To present information</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2. To model a skill to large group (e.g., NOT coaching)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3. For grading, attendance, or material preparation</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4. To retrieve information</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5. Other (write in)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6. Not using</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

**Protocol**: Note teacher use of technology. Mark all that apply. Describe technology used (e.g., name of software, items other than computer—digital camera, PDA, etc.).

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**4. STUDENT USE OF PRODUCTIVITY TOOLS**

**NETS*S 3.B.**

**STUDENTS USING:**

1. Word processing, publication software
2. Presentation software (e.g., PowerPoint)
3. Spreadsheet
4. Database
5. Authoring programs (e.g., HyperStudio, videoditing)
6. Graphics or graphic organizers (e.g., Photoshop, Inspiration)
7. Web authoring (e.g., Netscape Communicator, FrontPage)
8. Hardware (e.g., digital camera, graphing calculator, probes, PDA)
9. Other (write in)
10. None

**MARK ALL THAT APPLY**

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- 6
- 7
- 8
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**PROTOCOL.** Mark all that are used.

**RATIONALE.** Becker (1999) found that students use word processors most of the time. We will be able to report the extent of use of various productivity tools by PI students.
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5. STUDENT USE OF SUBJECT-SPECIFIC LEARNING TOOLS
NETS·S 6.A.

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</thead>
<tbody>
<tr>
<td>1. Simulation software (e.g., SimCity, SimLife, Jasper Woodbury)</td>
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<td>2. Drill and practice (e.g., keyboarding tutorials, Reader Rabbit, games that teach specific facts)</td>
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<td>3. Problem solving (e.g., Thinking Things, Tesselations)</td>
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<td>4. Textbook-linked software</td>
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<td>5. Learning/assessment software (e.g., Accelerated Reader, Star Reader, Star Math)</td>
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<tr>
<td>6. Other (write in)</td>
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<td>7. None</td>
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</tbody>
</table>

MARK ALL THAT APPLY

PROTOCOL. Mark all that are used. Simulation software includes software that presents a "real life" problem to students that they attempt to solve by selecting a series of appropriate strategies. The problem is complex and authentic. Drill and practice software is typically used to master basic facts (as in math) or essential information (e.g., Carmen San Diego for geography).

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<table>
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<tr>
<th>SEGMENT</th>
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</tbody>
</table>

**6. STUDENT USE OF INTERACTIVE COMMUNICATION TOOLS**

**NETS-S 4**

**STUDENTS USING:**

1. E-mail
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1
   - 1

2. Bulletin board, listerv
   - 2
   - 2
   - 2
   - 2
   - 2
   - 2
   - 2
   - 2
   - 2
   - 2
   - 2
   - 2
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   - 2
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3. Two-way video
   - 3
   - 3
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4. Other (write in)
   - 4
   - 4
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5. None
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**MARK ALL THAT APPLY**

**PROTOCOL.** Mark all that apply. Communication tools include those applications that allow students to exchange information with other individuals.

**RATIONALE.** Provides descriptive data of type of technology, purpose, and extent of use (percentage of time).
7. STUDENT USE OF RESEARCH TOOLS
NETS-S S.A.

<table>
<thead>
<tr>
<th>SEGMENT</th>
<th>TIME</th>
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<tbody>
<tr>
<td></td>
<td>1</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>STUDENTS GATHER INFORMATION FROM:</td>
<td></td>
</tr>
<tr>
<td>1. CD-ROM (e.g., encyclopedia or Web-based databases)</td>
<td>1</td>
</tr>
<tr>
<td>2. Internet search engines</td>
<td>2</td>
</tr>
<tr>
<td>3. Internet Web sites</td>
<td>3</td>
</tr>
<tr>
<td>5. Automated library system (e.g., OPAC station)</td>
<td>5</td>
</tr>
<tr>
<td>6. Other (write in)</td>
<td>6</td>
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<tr>
<td>7. None—skip question 8</td>
<td>7</td>
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</tbody>
</table>

MARK ALL THAT APPLY

PROTOCOL. Mark all that apply.

RATIONALE. Provides descriptive data of type of technology, purpose, and extent of use (percentage of time).

Continued
### B. PURPOSE OF RESEARCH TOOLS
#### NETS•S S.B.

<table>
<thead>
<tr>
<th>STUDENTS USE TECHNOLOGY RESEARCH TOOLS:</th>
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</thead>
<tbody>
<tr>
<td>1. To locate information independently (e.g., use self-selected search strategies—keyword search, etc.)</td>
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<tr>
<td>2. To locate information under teacher direction (e.g., using teacher bookmarks, Web page with constructed links, teacher-specified keywords)</td>
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<td>3. To select information by cutting and pasting, taking notes, printing, downloading</td>
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**PROTOCOL.** Mark all that apply.
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**9. STUDENTS' LEVEL OF TECHNICAL SKILLS**

**NETS-S 1**

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<tr>
<th>STUDENTS' LEVEL OF TECHNICAL SKILL:</th>
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<tbody>
<tr>
<td>1. Need lots of help</td>
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<tr>
<td>2. Somewhat skilled, but need help of teacher</td>
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<tr>
<td>3. Independent—clearly know how to operate the hardware and software they are expected to use and/or strategies are in place to assist students with problems so work is not slowed down.</td>
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**PROTOCOL.** Focus only on the students using technology during this segment. Summarize your impression over this entire segment.

*Need lots of help*—more than 20% of the students are unable to proceed with tasks because they are having difficulty and are waiting for teacher attention.

*Somewhat skilled*—10-20% of students need assistance; others solve technical problems by asking an expert, referring to aids, or other strategies.

*Independent*—less than 10% need assistance; most try other strategies before asking for help. Strategies are in place so students can continue working.

**RATIONALE.** Because we are asking to observe a showcase lesson that integrates technology, we do not expect to see students still learning the technology at beginning levels. Percentage of time that students can operate without direct teacher assistance is an indication that the teacher has selected a technology at the appropriate level of difficulty and prepared students with skills and strategies to learn effectively using their own or classroom resources.
## 10. COGNITIVE LEVEL OF TASKS

What cognitive task(s) did the teacher set for students [e.g., practice, recall, create, organize, compare/contrast, evaluate/analyze]? Mark primary or highest level of thinking indicated per task.

<table>
<thead>
<tr>
<th>TASK</th>
<th>KEY WORDS (How was technology used for each cognitive task?)</th>
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<th>C</th>
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<th>C/C</th>
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**PRACTICE AND RECALL—Declarative Knowledge**

**CREATE AND ORGANIZE—Procedural Knowledge**

**COMPARE/CONTRAST AND EVALUATE/ANALYZE—Conditional Knowledge**


Declarative knowledge is "knowing that" something is the case. The common-sense use of the term knowledge usually refers to declarative knowledge—facts, beliefs, theories, opinions; poems or passages or song lyrics; rules, names, and so on. Robert Gagne (1985) calls this category verbal information. The range of declarative knowledge is tremendous. You can know very specific facts (the atomic weight of gold is 196.967), or generalities (leaves on some trees change color in autumn), or personal preferences (I don’t like lima beans), or personal events (what happened at my brother’s wedding), or rules (to divide fractions, invert the divisor and multiply). Small units of declarative knowledge can be organized into larger units; for example, principles of reinforcement and punishment can be organized in your thinking into a theory of behavioral learning (Gagne, Yekovich, & Yekovich, 1993).

Procedural knowledge is "knowing how" to do something such as divide fractions or clean a carburetor. Notice that repeating the rule "to divide fractions, invert the divisor and multiply" shows declarative knowledge—the student can state the rule. But to show procedural knowledge, the student must divide correctly. Robert Gagne (1985) calls this kind of knowledge intellectual skills. Students demonstrate procedural knowledge when they translate a passage into Spanish or correctly categorize a geometric shape or diagram a sentence.

Conditional knowledge is "knowing when and why" to apply your declarative and procedural knowledge. Robert Gagne (1985) calls this kind of knowledge cognitive strategies. Given many kinds of math problems, it takes conditional knowledge to know when to apply one procedure and when to apply another to solve each. It takes conditional knowledge to know when to read every word in a text and when to skim. For many students, conditional knowledge is a stumbling block. They have the facts and can do the procedures, but they don’t seem to apply what they know at the appropriate time (Woolfolk, 1995, pp. 242–3).
Appendix E
Snapshot Assessment Instrument

<table>
<thead>
<tr>
<th>Access</th>
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<tbody>
<tr>
<td>Number of computers</td>
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<td>Number with Internet access</td>
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<td>Number of computers in use</td>
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<tr>
<td>Number of computers used by students</td>
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<table>
<thead>
<tr>
<th>Students are</th>
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<tbody>
<tr>
<td>Working in a context or topic of obvious interest</td>
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<td>Actively engaged in learning</td>
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<thead>
<tr>
<th>Standards and Curriculum</th>
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<tbody>
<tr>
<td>The standard being addressed is apparent</td>
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<table>
<thead>
<tr>
<th>Teacher is</th>
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<tbody>
<tr>
<td>Directing whole group—one way interaction</td>
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<td></td>
</tr>
<tr>
<td>Interacting with whole group—two way interaction</td>
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<tr>
<td>Facilitating/coaching individuals or groups</td>
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<tr>
<td>Managing behavior or materials</td>
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<td></td>
</tr>
<tr>
<td>Facilitating effective technology use</td>
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<table>
<thead>
<tr>
<th>SPECIALIZED TOPICS</th>
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<tbody>
<tr>
<td>Professional Development</td>
<td></td>
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<tr>
<td>There is evidence of professional development in action</td>
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<table>
<thead>
<tr>
<th>Standards and Curriculum</th>
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<tbody>
<tr>
<td>Activities connect technology and curriculum standards</td>
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<tr>
<th>COMMENTS</th>
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Appendix F

THE ISTE NETS-T For Teachers

1. Facilitate and inspire Student Learning and Creativity
   Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments. Teacher:
   a. Promote, support, and model creative and innovative thinking and inventiveness
   b. engage students in exploring real-world issues and solving authentic problems using digital tools and resources
   c. promote student reflection using collaborative tools to reveal and clarify students’ conceptual understanding and thinking, planning, and creative processes
   d. Model collaborative knowledge construction by engaging in learning with students, colleagues, and others in face-to-face and virtual environments

2. Design and Develop Digital-Age Learning Experiences and Assessments
   Teachers design, develop, and evaluate authentic learning experiences and assessment incorporating contemporary tools and resources to maximize content learning in context and to develop the knowledge, skills, and attitudes identified in the NETS-S. Teachers:
   a. Design or adapt relevant learning experiences that incorporate digital tools and resources to promote student learning and creativity.
   b. Develop technology-enriched learning environments that enable all students to pursue their individual curiosities and become active participants in setting their own educational goals, managing their own learning, and assessing their own progress
   c. Customize and personalize learning activities to address students’ diverse learning styles, working strategies, and abilities using digital tools and resources
   d. Provide students with multiple and varied formative and summative assessments aligned with content and technology standards and use resulting data to inform learning and teaching

3. Model Digital-Age Work and Learning
   Teachers exhibit knowledge, skills, and work processes representative of an innovative professional in a global and digital society. Teachers:
   a. Demonstrate fluency in technology systems and transfer of current knowledge to new technologies and situations
   b. Collaborate with students, peers, parents, and community members using digital tools and resources to support student success and innovation.
   c. Communicate relevant information and ideas effectively to students, parents and peers using a variety of digital-age media and formats
   d. Model and facilitate effective use of current and emerging digital tools to locate, analyze, evaluate, and use information resources to support research and learning

4. Promote and Model Digital Citizenship and Responsibility
   Teachers understand local and global societal issues and responsibilities in an evolving digital culture and exhibit legal and ethical behavior in their professional practices. Teachers:
a. Advocate, model, and teacher safe, legal, and ethical use of digital information and technology, including respect for copyright, intellectual property, and the appropriate documentation of sources.

b. Address the diverse needs of all learners by using learner-centered strategies and providing equitable access to appropriate digital tools and resources.

c. Promote and model digital etiquette and responsible social interactions related to the use of technology and information.

d. Develop and model cultural understanding and global awareness by engaging with colleagues and students of other cultures using digital-age communication and collaboration tools.

5. Engage in Professional Growth and Leadership

Teachers continuously improve their professional practice, model lifelong learning, and exhibit leadership in their school and professional community by promoting and demonstrating the effective use of digital tools and resources. Teacher:

a. Participate in local and global learning communities to explore creative applications of technology to improve student learning.

b. Exhibit leadership by demonstrating a vision of technology infusion, participating in shared decision making and community building, and developing the leadership and technology skills of others.

c. Evaluate and reflect on current research and professional practice on a regular basis to make effective use of existing and emerging digital tools and resources in support of student learning.

d. Contribute to the effectiveness, vitality, and self-renewal of teaching profession and of their school and community.
Appendix G

Courses in the MAU Teacher Preparation Program that Cover Areas of the TPACK for students in the Elementary and Special Education Emphases

<table>
<thead>
<tr>
<th>Course Prefix and Number</th>
<th>Course Title</th>
<th>Domain of TPACK Covered</th>
<th>Ways Domain Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDIS 3450</td>
<td>Teaching with Technology</td>
<td>Technological Content Knowledge</td>
<td>Model and use of content specific technology</td>
</tr>
<tr>
<td>EDIS 5440</td>
<td>Applied Teaching with Technology</td>
<td>Technological Content Knowledge</td>
<td>Model and use of content specific technology</td>
</tr>
<tr>
<td>EDIS 5320</td>
<td>Mathematics in the Elementary School</td>
<td>Technological Pedagogical Knowledge</td>
<td>Model of how technology can be used to enhance content.</td>
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<tr>
<td>EDIS 5300 &amp; 5310</td>
<td>Language Skills Block I &amp; II</td>
<td>Technological Pedagogical Knowledge</td>
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<tr>
<td>EDIS 5340</td>
<td>Teaching Social Studies in the Elementary School</td>
<td>Technological Pedagogical Knowledge</td>
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<tr>
<td>EDIS 5330</td>
<td>Science in the Elementary School</td>
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Courses in the MAU Teacher Preparation Program that Cover Areas of the TPACK for students in the Secondary Math and Science Emphases

<table>
<thead>
<tr>
<th>Course Prefix and Number</th>
<th>Course Title</th>
<th>Domain of TPACK Covered</th>
<th>Ways Domain Covered</th>
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</thead>
<tbody>
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<td>EDIS 3450</td>
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<tr>
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<td>Applied Teaching with Technology</td>
<td>Technological Content Knowledge</td>
<td>Model and use of content specific technology</td>
</tr>
<tr>
<td>EDIS 5450 &amp; 5451</td>
<td>Teaching Mathematics in Secondary Schools I &amp; II</td>
<td>Technological Pedagogical Knowledge</td>
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</tr>
<tr>
<td>EDIS 5050 &amp; 5051</td>
<td>Teaching Science in Secondary Schools I &amp; II</td>
<td>Technological Pedagogical Knowledge</td>
<td>Model of how technology can be used to enhance content.</td>
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</table>
Courses in the MAU Teacher Preparation Program that Cover Areas of the TPACK for students in the Secondary English and Social Studies Emphases

<table>
<thead>
<tr>
<th>Course Prefix and Number</th>
<th>Course Title</th>
<th>Domain of TPACK Covered</th>
<th>Ways Domain Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDIS 3450</td>
<td>Teaching with Technology</td>
<td>Technological Content Knowledge</td>
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<tr>
<td>EDIS 5440</td>
<td>Applied Teaching with Technology</td>
<td>Technological Content Knowledge</td>
<td>Model and use of content specific technology</td>
</tr>
<tr>
<td>EDIS 5400 &amp; 5401</td>
<td>Teaching English in Secondary Schools I &amp; II</td>
<td>Technological Pedagogical Knowledge</td>
<td>Model of how technology can be used to enhance content.</td>
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<tr>
<td>EDIS 5600 &amp; 5601</td>
<td>Teaching Social Studies in the Secondary School I &amp; II</td>
<td>Technological Pedagogical Knowledge</td>
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