AN INVESTIGATION INTO THE RELATIONSHIPS BETWEEN THE TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE OF UNIVERSITY TEACHER EDUCATION FACULTY AND THEIR AGE, RANK, AND GENDER

Christina Hamilton, B.S., M.Ed.

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APPROVED:

James Young, Major Professor
Christina Gawlik, Committee Member
Mei Hoyt, Committee Member
James Laney, Committee Member and Chair of the Department of Teacher Education and Administration
Jerry Thomas, Dean of the College of Education
Mark Wardell, Dean of the Toulouse Graduate School
Hamilton, Christina. *An investigation into the relationships between the technological pedagogical content knowledge of university teacher education faculty and their age, rank, and gender.* Doctor of Philosophy (Curriculum and Instruction), August 2013, 101 pp., 21 tables, 2 figures, references, 121 titles.

The purpose of this study was to determine what relationships exist between the age, rank, and gender of university faculty in teacher education and their technological pedagogical content knowledge. The survey instrument used was the Survey of Teacher Educators’ Technological Pedagogical Content Knowledge (TPACK) which is an adaptation of the Survey of Preservice Teachers’ Knowledge of Teaching and Technology developed by Schmidt. A total of 347 public Texas university teacher education faculty members participated in the study. Multiple regressions were utilized and the effect size was considered to determine the strength of the relationship between the variables.

A statistical significance was found relating to the age, rank, and gender of the university teacher educator faculty member and their technological knowledge (TK). Based on the information provided for the $b$ weights, age was found to be the best predictor of their technological knowledge (TK). The discriminant analysis identified what relationship exists between the ages of university teacher education faculty technology knowledge. The results of the discriminant analysis indicate the range 20-30 and 60+ contribute equally to teacher educators’ technological knowledge. Although no statistically significant results were determined with respect to the correlations between gender, age, and rank and technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge, the descriptive data does suggest that some insight maybe gained from further analysis.
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by

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CHAPTER 1
INTRODUCTION

This chapter provides a brief background into the focus of this study on the technological pedagogical content knowledge (TPACK) of teacher education faculty. After that, a statement of the problem, the purpose of the study, the research questions, the theoretical framework, and an overview of the selected methodology will be explained. Lastly, a rationale for the need of the research and significance of the research, the assumptions, limitations, and delimitations of the research will be presented, followed by a chapter summary.

Background

Scriven (1988) believes the teaching profession is comparable to other professions such as law or medicine in that they all have traditional standards that originate from historical values. For example, a teacher is expected to teach students, a lawyer is expected to defend clients, and a medical professional is expected to provide healing to the ill. The influx of technology in all aspects of society has provided the listed professions with numerous approaches to further improve their professional practices.

Students who hope to work in those professions learn how to utilize specialized technologies. For example, students in the medical field learn how to use medical technologies and students hoping to become attorneys learn how to navigate legal databases. However, pre-service teachers are not adequately learning how to use educational technologies while completing their teacher preparation studies (U.S. Congress, 1995; Sang, Valcke, van Braak, & Tondeur, 2010; Tearle & Golder, 2008). This is evident from a national survey conducted in 1994 in which a majority of new teachers self-reported that they had limited or no training on how to use educational technologies (Willis et al., 1994). Most recently, a research by the
National Center for Education Statistics (NCES) reported that only 30% of the current public school educators feel comfortable using technology in their classrooms (Rosenthal, 2009).

Likewise, Carson and Gooden (1999) through their research confirmed that many pre-service teachers feel that they are not prepared to teach using technology after they graduate. Specifically, according to research conducted by Francis-Pelton, Farragher, & Riecken (2000) two-thirds of exiting preservice teachers report they are not ready to integrate technology into their future classrooms. To add, Smith and Shotsberger (2001) concluded that most pre-service teachers do not feel prepared to teach using technology. Recently, the International Society for Technology in Education (ISTE) (2002, 2005) stated that, although teachers have more access to technology than in years past, most are not sufficiently trained to effective use the technology in their classrooms.

Attention has been given to the lack of teacher preparation in the area of educational technology. This is evident in the 1996 State of the Union Address by President Bill Clinton, who advocated for every classroom to have well-trained teachers (Clinton, 1996). President Clinton aim was to emphasize the importance of having teachers trained in the use of educational technologies that are appropriate for their content areas. As a result, the U.S Department of Education developed the “Preparing Tomorrow’s Teachers to Use Technology” (PT3) initiative that provided universities funds to support their development of technology integration experiences for preservice teachers (Lawless & Pellegrino, 2007). This program was in existence from 1999 to 2003 and supplied $750 million to selected technology integration based projects.

Currently, the National Education Technology Plan (NETP, 2010) presented by President Barack Obama is in place to ensure technology integration exist at the university level.
Specifically, a component of the NETP addresses the need for technology to become an integral component of pre-service and in-service professional development experiences.

Thus, interest in the technology component in teacher education programs became a focal point in educational reform. National professional organizations charged universities with the task of providing learning experiences for pre-service teachers in the realm of educational technologies. For example, the National Council of Teachers of Mathematics (NCTM) released a technology position paper that states, “Mathematics teacher preparation programs must ensure all mathematics teachers and teacher candidates have opportunities to acquire the knowledge and experiences needed to incorporate technology in the teaching and learning of mathematics” (NCTM, 2003, p. 2).

Moreover, the National Council for Accreditation of Teacher Education (NCATE) and the International Society for Technology in Education (ISTE) adopted standards related to the inclusion of technology in teacher education programs. They suggested that “teacher preparation programs provide prospective teachers opportunities to learn important skills and examine pedagogical issues for using technology in the classroom” (Kersaint et al., 2003, p. 549). In addition, in 1996, the National Science Education Standards (NSES) adopted a technological content strand that called for, “science content knowledge and practical skills to be integrated with personal, social, and technological perspectives previously relegated into separately taught content areas of science” (Raizen, 1998, p 69).

Furthermore, the National Technology Leadership Initiative (NLTI) was created in 1996 to ensure and highlight technology integration into pre-service teacher content area coursework. The NLTI, a collaboration of 12 professional organization representatives from the fields of
mathematics, science, English, and social studies, who publish goals on how to best integrate technology into teacher education in their respective content areas found in publishes issues concerning technology integration in teacher education in Contemporary Issues in Teacher Education (CITE) (Dexter, Doering, & Riedel, 2006).

The position of the above-mentioned professional organizations, regarding integrating educational technology into teacher education, stems from research that generally implies that the use of technology among pre-service teachers is influenced by the technological experience they acquired while completing their teacher education. According to the Office of Technology Assessment (1998), the level of technology training of teachers while completing their teacher preparation is an important predictor of their classroom implementation of that technology. Research conducted by Munday, Windham, and Stamper (1991) revealed that teachers who are competent users of technology have positive attitudes toward the integration of technology into their classrooms. Munday, Windham, and Stamper further explained that this attitude develops as a result of the teachers’ experiences with technology as modeled by teacher preparation educators.

Given the presumption that teachers teach as they were taught, it is indisputably the responsibility of faculty members in teacher education to preparing pre-service teachers for technology integration into their future classrooms. Therefore, to effectively prepare pre-service teachers to integrate technology into their future classrooms, university faculty members in teacher education must have the knowledge to do so (Stanford & Reeves, 2007).

Researchers have affirmed that university faculty members are not adequately using content-specific educational technologies in their teacher preparation classrooms in ways that will transfer to best practices by their pre-service teachers. For instance, scholars have concluded
that university faculty members in teacher education are not using instructional technologies (Ching, Levin, & Parisi, 2004; Marx, 2005; Selwyn, 2007). Research conducted by Becker (1999) concluded that 70% of university faculty was not using instructional technologies in their pre-service classrooms. In addition, in 1997, the National Survey of Information Technology surveyed 557 universities and found that 75.8% of university faculty adopted technology in their courses primarily for administrative tasks (Green, 1999). Years later, this issue still exists because according to recent data from the 2005 The National Survey of Postsecondary Faculty that indicates 82% of faculty use technology primarily for email and only 50% used technology in their teaching (Meyer and Xu, 2009).

A reported reason why teacher educators are not using technology in their pre-service teacher classrooms was that they lack the vision to understand how it could be used (Willis et al, 1994). Another reason was they were never trained to use educational technology in their content areas (Vannatta & Beyerbach, 2000). In addition, university faculty may not use educational technologies due to a lack of urgency by their universities for them to do so. Additionally, university faculty are most often left to seek and learn how to use content-related technologies on their own, which may be difficult to do and may defer them from doing so (Bryant, 2001).

Whatsoever the reason, it is a major problem in education because university faculty members in teacher education are a primary source in reference to pre-service teachers exposure to instructional technology in their content areas.

Statement of the Problem

The education profession has tasked teacher educators with providing pre-service teachers with the technology experiences needed to implement technology into future classrooms. However, it is questionable whether current teacher educators are adequately
prepared for such an undertaking. Beaver (1992) has documented that teacher educator’s lack expertise in instructing the use of technology.

Consequently, lack of knowledge of how to incorporate this instruction into their practices may influence their students’ technological outcomes. Kaput (1992) implied that the use of technology in the classroom requires the integration of three forms of knowledge: subject matter knowledge, student learning theory knowledge, and knowledge of individual learners at each stage of the technology integration process. This knowledge is described by Mishra and Koehler (2006) as technological pedagogical content knowledge (TPACK) (p.34). The TPACK framework consists of seven domains that encompass the knowledge required to teach with technology effectively:

- Technology knowledge (TK): Knowledge of various technologies;
- Content knowledge (CK): Knowledge of a specific content;
- Pedagogical knowledge (PK): Knowledge of methods and processes of teaching;
- Pedagogical content knowledge (PCK): Knowledge of content knowledge that deals with the teaching process;
- Technological content knowledge (TCK): Knowledge of how technology can create new representations for specific content;
- Technological pedagogical knowledge (TPK): Knowledge of how various technologies can be used in teaching;
- Technological pedagogical content knowledge (TPACK): Knowledge required by teachers to integrate technology into their teaching in any content area.

The majority of current literature pertaining to TPACK is centered on pre-service and in-service teachers. This is unfortunate as the TPACK of teacher educators is transferred to pre-
service and in-service teachers directly or indirectly; therefore, the technological strengths and weaknesses of faculty will be mirrored in the P–12 classrooms of their pre-service students. For example, teacher educators who model the use of technology to provide constant student–teacher communication—such as educational blogging sites or Edmodo (which is social networking learning environment similar to “Facebook”) in their pre-service classrooms—will likely influence their pre-service teachers to follow suit in terms of using the technology in their future classrooms.

Not only is knowledge of how to incorporate instructional technologies into one’s pedagogy and content important but so is the issue of obstacles that may influence their technology usage. Factors such as age, gender, and rank have been identified as influences of technology use by university faculty (Velasquez-Bryant, 2002; Wang, 2006). Thus, the relationship of university faculty TPACK and their age, rank, and gender will be addressed in this research study.

The TPACK of teacher educators is equally as important as that of pre-service and in-service teachers. Herein lies the problem: Not enough attention has been given to the TPACK of university faculty in teacher education, despite their immediate influence on pre-service and in-service teachers’ use of educational technology in future classrooms. Thus, the problem of this current study is to identify the relations that exist between university teacher educators’ TPACK and their age, rank, and gender.

Purpose of the Study

The purpose of this study is to determine what relations exist between the age, rank, and gender of university faculty in teacher education and their TPACK. This will be done by investigating the relations of self-reported TPACK of teacher educators according to the TPACK
knowledge constructs and their age, rank, and gender. To accomplish this task, quantitative data will be collected from university faculty in teacher education regarding their perceptions, knowledge, and use of educational technology through an online TPACK instrument as defined in the TPACK framework.

This study adds to current literature concerning TPACK to include university faculty teacher educators. An abundance of research has already been conducted on teacher educators’ pedagogical knowledge (PK), content knowledge (CK), and pedagogical content knowledge (PCK); therefore, this study will focus only on technological knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) domains of TPACK. This research will be useful in promoting TPACK awareness at the collegiate level. With the increase awareness of educators’ TPACK, universities would be able to provide specific professional development to increase technology use.

Research Questions and Hypotheses

1. What is the relationship between the perceived technological knowledge of university faculty in teacher education and their age, rank, and gender?
   
   HO 1.1 There will be no relationship between the perceived technological knowledge of university faculty in teacher education and their age, rank, and gender.

2. What is the relationship between the perceived technological content knowledge of university faculty in teacher education and their age, rank, and gender?
   
   HO 2.1 There will be no relationship between the perceived technological content knowledge of university faculty in teacher education and their age, rank, and gender.
3. What is the relationship between the perceived technological pedagogical knowledge of university faculty in teacher education and their age, rank, and gender?

HO 3.1 There will be no relationship between the perceived technological pedagogical knowledge of university faculty in teacher education and their age, rank, and gender.

4. What is the relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?

HO 4.1 There will be no relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?

Investigating the listed research questions will accomplish the purpose of providing preliminary research on the TPACK of university faculty members in teacher education. It will also provide data pertaining to the relationship between the TPACK of the faculty members and their age, rank, and gender (listed in Table 3.1). Thus, the results of this study will provide viable information when considering developing a professional development program or evaluating potential faculty candidates.

Theoretical Framework

The theoretical framework developed by Mishra and Koehler (2006) in reference to technological pedagogical content knowledge (TPACK) (see Figure 1.1) will be used to identify the technological knowledge needed for teaching. TPACK is an expansion of Shulman’s (1986) pedagogical content knowledge (PCK) framework. PCK is the concept of the teacher having adequate academic content knowledge.
Shulman (1986) attempted to align his concept of academic content knowledge to John Dewey’s idea of the difference between teacher content knowledge and professional content knowledge as presented in *The Child and the Curriculum*. Dewey indicated that knowing content is important to professionals and teachers; however, the separation of the two comes when they apply their content knowledge in their respective settings, whether they are academic or professional. For example, teachers apply their content knowledge in a manner that attempts to produce student learning, while professionals apply their content knowledge to implement processes or to invent in their fields. More specifically, a mathematics teacher applies his or her academic content knowledge of measurement to facilitate student learning in terms of the concept of measuring such things as surface area. A mathematician applies her or his professional content knowledge of measurement to develop innovations using the surface area of figures.

Shulman (1986) stated that Bruner’s structure of knowledge theory influenced his theory of PCK. Bruner’s structure of knowledge theory implies a teacher must have the knowledge of how to present academic content in a way that can be mastered by any learner. This is evident in Shulman’s definition of PCK (1987, p. 8), in which he concluded that if PCK could be confined to a handbook, the chapter headings would be, at minimum, as follows:

- Content knowledge;
- General pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter;
- Curriculum knowledge, with a particular grasp of the materials and programs that serve as tools of the trade for teachers;
• Pedagogical content knowledge, that special amalgam of content and pedagogy uniquely the province of teachers that represents their own special form of professional understanding;

• Knowledge of learners and their characteristics;

• Knowledge of educational contexts, ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures; and,

• Knowledge of educational ends, purposes, and values and their philosophical and historical grounds.

TPACK is an extension of Shulman’s ideas in terms of the importance of teacher knowledge including a technology component. Mishra and Koehler (2006) defined the TPACK framework as three overlapping circles that illustrate the interrelationships between the components of technology knowledge, pedagogical knowledge, and content knowledge (see Figure 1.1). It is at this intersection where the teacher understands how to teach content with appropriate pedagogical methods and technologies (Schmidt, Baran, Thompson, Koehler, Shin, & Mishra, 2009).
The rationale for selecting TPACK as the theoretical framework for this research is that teacher educators must have knowledge of how to use technological tools in reference to their established content and pedagogy. Doing so allows them to influence their pre-service teachers to use technology because teachers teach as they are taught. This means that a new teacher will most likely be more willing to integrate technology into her or his classroom if she or he is exposed to technology during teaching preparation courses. A more detailed review of the TPACK framework can be found in Chapter 2.
Overview of the Methodology

This study will use a correlational research method to investigate the relationships between the TPACK domains (dependent variables) of faculty in teacher education and their age, rank, and gender (independent variables, see Table 3.1). A correlational research method attempts to understand the patterns of relationships between two or more variables (Gravetter & Wallnau, 2005; Gay, Mills, & Airasian, 2006; Glatthorn, 1998). This study will test the hypothesis that there is a relationship between the dependent variables (TPACK domains) and the independent variables (age, rank, and gender). A multiple regression analysis will be used to determine if statistical significant relationships exist and a discriminant analysis will be used to determine the nature of the identified relationship(s).

The participants of this study are faculty in teacher education from 76 public universities in Texas. They will complete an online survey using Qualtrics in December 2012 and a second opportunity will be given to the participants to complete the survey in January 2013. The survey is a modified version of the Survey of Preservice Teachers Knowledge of Teaching and Technology, developed by Schmidt et al. (2009), and named Survey of Teacher Educators Technological Pedagogical Content Knowledge (TPACK). The purpose of using an online survey to gather the quantitative data for this study is to stay aligned with current quantitative TPACK research that uses survey research as the primary data collection method. A multiple regression as well as a discriminant analysis will be conducted to test the nature of the relationships of the research questions.

Significance of the Study

This study will investigate teacher educators’ perceived knowledge of how to integrate technology into their pedagogy and content. Similar to the importance of the knowledge of pre-
service or in-service teachers’ technological knowledge, examining the knowledge of teacher educators will provide data into reasons for the inclusion or exclusion of technology into their method courses.

The exploration of this knowledge will further assist teacher education programs to develop measures to increase the pedagogical technology content knowledge of their faculty. The majority of the research involving TPACK focuses on the knowledge of pre-service and in-service teachers. This is a limitation due to the fact that teacher educators are also teachers who need the same knowledge. Thus, this study has the potential to affect teacher education by providing insight into how teacher educator knowledge of technology may influence their instructional practices in reference to pre-service teachers, which will, in turn, affect the pre-service teachers influence their instructional practices their future classrooms.

Finally, the analysis of the nature of the relationships between the age, rank, and gender of university teacher education with their TPACK will allow researchers to begin to specify demographic obstacles to technology implementation. The results of this study have the potential to contribute to the current body of knowledge in the area of how faculty in teacher education can integrate technology into their teacher education courses.

Assumptions

This study assumes that teacher educators have access to educational technologies. It also assumes that, in teacher education, the technological pedagogical content knowledge of method course educators determines the kinds of instructional practices used in their classrooms. Simply, it is assumed that if faculty in teacher education has TPACK, then they will model effective technology use in content-specific learning situations. This, in turn, will influence their pre-service students to integrate technology into their future classrooms. Although other factors, such
as technology, self-efficacy, availability, and perception, influence pre-service teachers’
technology integration, this study will address the teacher educators’ knowledge regarding the
use of technology based on their own technological experiences

Limitations and Delimitations
A limitation as well as a delimitation of this study is the participants will be chosen by
convenience, not randomly; thus, they do not represent the population of all teacher faculty
members in public and private universities in Texas, just in 76 public universities.

Definitions of Key Terms
Operational definitions were established for the following terms: technology, educational
technology, instructional technology, TPACK, and university faculty. Understanding these
operational definitions enables understanding of the purpose of the research study and to
comprehend the results (Gay et al., 2006).

- Technology: lacks a formal definition (Hew and Brush, 2007) by researchers; thus for
  the purposes of this research technology refers to a variation of computing devices as
  well as information and communications technologies

- Educational technology or instructional technology: defined by Lever-Duffy, McDonald,
  and Mizell (2005) as, “any technology used by educators in support of the teaching and
  learning process” (p. 5). For example, technologies used for educational purposes are
  content-specific educational software, online communication, lesson presentation
  software and hardware, WebQuests, Smartboard technologies, interactive whiteboards,
  classroom response systems, Internet tools, online software, computers, tablets, iPads,
  and online classroom management systems such as Blackboard Courseware.
- Technological Pedagogical Content Knowledge (TPACK): knowledge about how to incorporate a technological tool in a content-specific lesson. TPACK is a sum of one’s pedagogical knowledge (PK), content knowledge (CK), pedagogical content knowledge (PCK), technological knowledge (TK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK).

- Faculty: anyone who teaches undergraduate or graduate level university courses and who holds a doctoral degree.

Summary

This chapter was dedicated to offering a brief synopsis of this research study which will investigate the relationships between university faculty of teacher education TPACK and their age, rank, and gender. In addition, a brief introduction discusses the purpose and significance of the study, and identifies key questions and hypotheses that are explored in the study. A short overview of the methodology within this research study was highlighted. In addition the assumptions, limitations/delimitations, and definitions of terms were noted.

Chapter 2 reviews relevant literature pertaining to this research study. This chapter provides a review of current literature devoted to the TPACK of faculty in teacher education. Specifically, this chapter provides an overview of the following concepts: the theoretical perception of educational technology, Pedagogical Content Knowledge (PCK), Technological Pedagogical Content Knowledge (TPACK), knowledge of teaching with technology, university faculty perceptions, use, and abilities in terms of educational technology, technology mandates in teacher education, technology use by teacher education faculty, and faculty age, rank, and gender as they relate to technology integration.
CHAPTER 2
REVIEW OF THE LITERATURE

Introduction

The purpose of this study is to determine what relationships exist between the age, rank, and gender of university faculty in teacher education and their TPACK. Chapter 1 introduced the research problem background, research questions, and hypotheses and other identifying information about this study. This chapter provides a review of current literature devoted to the TPACK of faculty in teacher education. It will provide an overview of the following concepts: the theoretical perception of educational technology, Pedagogical Content Knowledge (PCK), Technological Pedagogical Content Knowledge (TPACK), knowledge of teaching with technology, the uses and ability to use educational technology, technology mandates in teacher education, and faculty age, rank, and gender as they relate to technology integration.

The purpose of this research study is to add to literature of TPACK to include university teacher educators. In addition, the goal of this study is to investigate the relationships between teacher educators’ self-reported TPACK according to the TPACK knowledge constructs and their age, rank, and gender.

Research Questions and Hypotheses
1. What is the relationship between the perceived technological knowledge of university faculty in teacher education and their age, rank, and gender?

   HO 1.1 There will be no relationship between the perceived technological knowledge of university faculty in teacher education and their age, rank, and gender.

2. What is the relationship between the perceived technological content knowledge of university faculty in teacher education and their age, rank, and gender?
HO 2.1 There will be no relationship between the perceived technological content knowledge of university faculty in teacher education and their age, rank, and gender.

3. What is the relationship between the perceived technological pedagogical knowledge of university faculty in teacher education and their age, rank, and gender?

HO 3.1 There will be no relationship between the perceived technological pedagogical knowledge of university faculty in teacher education and their age, rank, and gender.

4. What is the relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?

HO 4.1 There will be no relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?

Theoretical Perception of Educational Technology

A massive technology shift has taken place in society which has influenced expectations in terms of the use of technology in education. This has been seen in educational reform as well as in the national recommendations of several professional organizations, technology has become a new factor in teaching and learning. Moreover, technology has created a learning environment that mirrors the lives of learners, meaning that students use familiar technologies in the classroom to create real life experiences. Thus, the use of technology encompasses the constructivist approach to learning. The learning theory of constructivism is situated around the
idea that students engage in active learning environments in order to create, as opposed to acquire knowledge (Wilson, 2010).

Technology has always influenced learning, a fact which is evidenced in the ideologies of several prominent philosophers, such as Dewey, Vygotsky, Piaget, and Bruner, all of whom centered their ideas on real life situations in the learning cycle through constructivist experiences (Javeri, 2003; Robyler & Edwards, 2000). Javeri (2003) stated that, “John Dewey’s idea of student-centered learning, Vygotsky’s work on the zone of proximal development and the importance of internalization, Bandura’s theory of social interaction are all attempts to structure learning in the contexts of real life situations” (p. 21).

To explain further, Dewey’s idea of student-centered learning refers to the notion that such learning takes place and is centered about an active student, meaning the student is actively involved in every phase of his or her learning. Technology is a tool that allows students to become active participants in daily lessons, during informal and formal assessments, as well as in instances in which they can communicate with their teachers or peers outside of the classroom. Dewey also assured the activities must be authentic and parallel to real world experiences. The use of technology in the learning process allow for authentic experiences that reflect real world experiences. For example, a student could communicate with similar students abroad to problem solve or to collaborate ideas pertaining to a specific subject matter.

Vygotsky’s zone of proximal development states, a learner can master difficult concepts with the help of someone more advanced in the subject matter (Penuel & Wertsch, 1995). This notion is tied to technology in that the teacher uses it as an advanced tool to help students understand difficult concepts. Technology is also indirectly referred to in Vygotsky’s social constructivist theory due to its ability to be used as a culturally cognitive stimulating tool to
encourage student development. For example, digital imaging could be used as cognitive stimuli for developing infants and could be used as components of video games. Bandura’s theory of social interaction implies that students learn from social interactions (Bandura, 1971). Technology is a social device in that students can communicate in classroom groups as well as globally in shared learning experiences.

Technology was originally used by Skinner as a behaviorist tool for the classroom, as seen in his “teaching machine” (Skinner, 1954, p. 3). Jacobsen (1958) stated that the use of technology in the classroom transitions teaching and learning from teacher-centered to student-centered, which complements the progression from a behaviorist approach to learning to a more constructivist approach. Jacobsen (1958) later claimed the integration of technology transformed the teacher from having the role of “sage on the stage” to a more “guide on the side” and the role of the student changed from being a passive receiver of knowledge to a more active participant in her or his learning.

Constructivists such as Papert initially planned technology to be partners in student learning, meaning the constructivist approach would play a role in the active knowledge acquisition and problem-solving learning process of the learner (Jacobsen, 1998). This is similar to the ISTE principle that states that technology and constructivism are partners in assuring that effective technology integration will be implemented in classrooms (Jacobsen, 1998).

Several philosophers have stated the importance of creating a rich learning environment that utilizes real life situations. Creating these real life situations has become readily available with the inclusion of educational technology in the learning process. Likewise, technology plays an important role in creating a constructivist way of learning. For example, the constructivist
approach to learning requires the learner to discover concepts to be mastered. With technology, this is possible through the use of simulation software.

Pedagogical Content Knowledge

In his 1986 presidential address to the American Educational Research Association (AERA), Lee Shulman (1986) presented pedagogical content knowledge (PCK), which he described as the transformation of subject matter knowledge into forms accessible to the students being taught. This transformation of subject matter knowledge for teaching involves the use of pedagogical knowledge—instructional practices, educational aims, knowledge of the learning process, knowledge of learners and classroom management skills, and knowledge of the broader context; in other words, it is the teacher’s knowledge of his or her students, the school, and the community. To come to the point, Shulman (1986) proclaimed that pedagogical content knowledge is the teachers’ knowledge and ability to represent and formulate the subject so as to make it comprehensible to others (p. 9). To have the ability to transform subject matter knowledge into tangible forms of knowledge, Shulman (1986) presented three forms of content knowledge, as follows:

(a) Subject matter content knowledge: This is knowledge of the standard concepts and facts of a subject. Teachers are also required to know beyond their taught grade level as well as how their concepts relate to other disciplines. For example, a mathematics teacher must know the standard facts and topics concerning slope as well as how it will be presented in upper level mathematics courses and how it is applied in the science discipline.

(b) Pedagogical content knowledge: This is the knowledge of how to practically teach content. For example, a mathematical teacher must know the standard facts and concepts pertaining to slope. In addition, the teacher must know how to facilitate student learning
of the mathematical concept. Within this knowledge domain, teachers must understand
the teaching and learning of their students; for instance, Shulman noted that teachers must
know the level of difficulty of each topic and students’ learning abilities.

(c) Curricular knowledge: This is the knowledge of the curriculum and the traditional
resources used to teach a specific concept, as well as alternatives. For example, an
algebra teacher must know how solving a linear equation is supposed to be taught as well
as how algebra tiles are commonly used to teach this concept.

To summarize, PCK represents the blending of content and pedagogy into an
understanding of how particular topics, problems, or issues are organized, represented, and
adapted to the diverse interests and abilities of learners and how they should be presented for
instruction (Shulman, 1987).

Grossman (1990) summarized Shulman’s PCK into four categories: the overarching
conception of teaching a subject, knowledge of instructional strategies and representations,
knowledge of students’ understanding and potential misunderstandings, and knowledge of
curriculum and curricular materials. In alignment with Grossman’s categories, the survey
instrument used for this study will utilize the four mentioned categories for each core content
area.

The Technological Pedagogical Content Knowledge (TPACK) Framework

Shulman (1986) referred to the theoretical framework of pedagogical content knowledge
PCK, which he describes as the transformation of subject matter knowledge into forms
accessible to the students being taught. However, Shulman's PCK goes beyond knowledge of the
subject matter per se to the dimension of subject matter knowledge for teaching (Shulman,
1986). Shulman (1986) proclaimed "pedagogical content knowledge as teachers’ knowledge and ability to –represent and formulate the subject that makes it comprehensible to others (p. 9)".

Given the technological advances of society that have entered the 21st century classroom, an effective teacher has adequate knowledge of how to integrate technology into his or her pedagogy and content is critical. For example, a 21st century teacher must know how to present the mathematical concept of slope using technology tools to enable students to accomplish the listed tasks previously mentioned. The knowledge of how to interject educational technology into current pedagogy and content is known as Technological Pedagogical Content Knowledge (TPACK).

The TPACK framework involves seven knowledge domains described by Mishra and Koehler (2006), as follows:

- Pedagogical knowledge (PK): This is knowledge of the “the collected practices, processes, strategies, procedures, and methods of teaching and learning. In addition it includes knowledge of the aims of education and instruction, assessment and evaluation, and student learning” (Koehler & Mishra, 2005, p. 3). Angeli and Valanides (2005) added that PK is the “activity of scaffolding, motivating students, and checking for understanding” (pg. 294).

- Content knowledge (CK): According to Shulman (1987), this is knowledge of the standard concepts and facts of a subject. Teachers are also required to know beyond their taught grade level as well as how their concepts relate to other disciplines. For example, a mathematics teacher must know the standard facts and topics concerning slope as well
as how it will be presented in upper level mathematics courses and how it is applied in the science discipline.

- Technology knowledge (TK): This is knowledge that is continually changing and evolving; it includes knowledge of technology for information processing, communications, and problem solving and focuses on the productive application of technology in both work and daily life. Koehler and Mishra (2008) add that it is the knowledge of how to recognize where technology can assist or impede learning (pg. 15).

- Pedagogical content knowledge (PCK): This is knowledge of how to practically teach content. For example, a mathematics teacher must know the standard facts and concepts pertaining to slope. In addition, the teacher must know how to facilitate student learning of the mathematical concept. Within this knowledge domain, teachers must understand the teaching and learning of their students; Shulman (1986) noted that teachers must know the level of difficulty of each topic and students’ learning abilities.

- Technological content knowledge (TCK): This is knowledge of how subject matter is transformed when using an educational technological tool (Koehler & Mishra, 2005). It is the knowledge of how to select the most effective technological tool to optimize student learning. For example, a mathematics teacher displays TCK when he or she chooses to use a Geometry Sketch Pad as a tool for students to investigate geometric objects and their properties.

- Technological pedagogical knowledge (TPK): This is knowledge of the understanding of the application of educational technology without reference to a specific content (Cox, 2008). Koehler and Mishra (2008) stated that it is the understanding of how teaching and
learning transform when educational technologies are used as tools in student learning, as well as how technology can support specific pedagogical goals and learning objectives. For example, TPK is the understanding of how to effectively use live video in a classroom or knowledge of online classroom management systems. Koehler and Mishra (2008) further emphasized that TPK is the ability to become creative and flexible in reference to learning new educational technological tools used for learning.

- Technological pedagogical content knowledge (TPACK): This is knowledge of how to incorporate a technological tool in a content-specific lesson. TPACK is a theoretical framework introduced by Mishra and Koehler (2006) that extends Shulman’s (1986) pedagogical content knowledge (PCK) theoretical framework, which explains the overlapping aspects of pedagogy and content. Mishra and Koehler (2006) defined the TPACK framework as three overlapping circles which illustrate the interrelationships between the components of technology knowledge, pedagogical knowledge, and content knowledge. Figure 1.1 illustrates the TPACK framework.

Just as Shulman’s PCK goes beyond knowledge of the subject matter per se to the dimension of subject matter knowledge for teaching (Shulman, 1986), TPACK is more than teachers’ personal use of technology; it is the effective use of technology within a teaching strategy as a pedagogical tool. Similarly, Mishra and Koehler (2006) affirmed that “TPACK is more than just an awareness of technology, pedagogy, and content; it is an awareness of the connections, interactions, affordances and constraints” (p. 1,025).

TPACK Research

TPACK has been accepted as a framework for research in teacher education pertaining to teacher use and knowledge of technology (Mishra & Koehler, 2006; Thompson, 2005). Research
studies thus far involving TPACK have explored the importance and development of TPACK among pre-service and in-service teachers as well as strategies for developing TPACK, ranging from mentoring to instructional systems designs (Keating & Evans, 2001; Margerum-Leys & Marx, 2000; Mishra & Koehler, 2006; Niess, 2005).

Current TPACK Survey Instruments

In an attempt to measure TPACK, Koehler and Mishra (2005) used a survey to assess changes in teachers’ perceptions of their understanding of content, pedagogy, and technology over the course of an instructional sequence emphasizing the design of educational technology (Schmidt, Baran, Thompson, Koehler, Shin, & Mishra, 2009). Their survey catered specifically to the teacher course experience, thus making it not generalizable to other contents, settings, or to professional development.

In another attempt that used a discourse analysis approach to track the development of TPACK, Koehler, Mishra, and Yahya (2007) analyzed the conversations of teachers working in design teams over the course of a semester. This approach is not generalizable, in addition to the fact that it is time-consuming. Thus, a standard measuring tool for TPACK is yet forthcoming.

A study conducted by Abbitt (2011) concerning the relationship between pre-service teachers’ TPACK and their self-efficacy in terms of technology integration concluded that the TPACK domains of TPK, TCK, and TPCK were strongly correlated to the pre-service teachers’ self-efficacy, whereby the PK, PCK, and CK domains were not significantly predicted by their levels of self-efficacy. The author implied that the findings sustain the belief that TPACK is a viable model for technology integration and that according to Ertmer and Ottenbeit-Leftwich (2010), TPACK knowledge and pedagogical beliefs are among the factors that influence technology integration.
A large-scale study of the TPACK of 1,185 Singaporean pre-service teachers conducted by Koh, Chai, and Tsai (2010a) sought to investigate the construct validity of the Survey of Preservice Teachers’ Knowledge of Teaching and Technology developed by Schmidt et al. (2009) using exploratory factor analysis. The factor analysis confirmed construct validity for the items in the sections of TK and CK. The authors credit the inexperience of the pre-service teachers for why the other TPACK domains (PK, PCK, TPK, TCK, and TPACK) were not established. To further investigate the construct validity of the TPACK survey created by Schmidt et al. (2009) using Singaporean pre-service teachers, the authors conducted another study that revealed construct validity for PK and TPACK (Koh, Chai, & Tsai, 2010b).

In addition, a study conducted by Burgoyne (2010) sought to assess the construct validity of the Survey of Preservice Teachers’ Knowledge of Teaching and Technology developed by Schmidt et al. (2009) using exploratory and a confirmatory factor analysis. The results revealed some evidence for construct validity; however, due to the general nature of the survey, the author suggested that minor changes be made to increase its construct validity.

Limiting current research of TPACK to only pre-service and in-service teachers has created a disadvantage in reference to increasing the TPACK of university faculty for the purposes of this study, which focuses on university faculty in teacher education. Reoccurring studies reveal that university faculty members lack the knowledge of how to integrate technology into their content area classrooms; thus, the need to research their TPACK is current in all efforts to increase technology integrations at all levels of education.

Knowledge of Teaching with Technology

Mishra and Koehler (2006) stated the importance of teachers knowing their subject matter and how their subject matter could be changed by using technological tools. Mishra and Koehler further indicate that teachers need basic knowledge of advanced technologies, such as
the Internet and digital technologies as well as skills needed to operate the listed technologies. To expand on the idea of digital technologies, Mishra and Koehler suggested that teachers should know how to operate different computer hardware components and software packages. In addition, they should know how to install and remove peripheral devices, install and remove software programs, and create and archive documents.

Mishra and Koehler (2006) not only listed the important aspects of computer hardware and software, they included the importance of teachers having knowledge of the existence of components and capabilities of various technologies used in teaching and learning. This would include knowing how to correctly choose tools used for particular educational tasks based on their fitness, strategies for their affordances, and knowledge of educational strategies used by each technological tool. For example, teachers should have knowledge of technologies used in generic classrooms, such as tools for maintaining classroom records, attendance, and grading. In addition, they should have knowledge of technologies that extend the learning environment for students, such as discussion boards, classroom response systems, interactive games and videos, live-steaming videos, and digital imaging.

Mishra and Koehler (2006) later summarized the fact that teaching with technology is a multi-facet endeavor that entails

an understanding of the representation of concepts using technologies, educational techniques that use technologies in constructive ways to teach content, knowledge of what makes concepts difficult or easy to learn and how technology can help address some of the problems that students face, knowledge of students’ prior knowledge and theories of knowledge; and also knowledge of how technologies can be used to build on existing knowledge and to develop new knowledge or strengthen old ones. (pp.1024-1025)
To conclude, Mishra and Koehler (2006) cited the importance of teachers knowing how to overcome technological obstacles and setbacks in order to creatively use technologies to meet educational goals, meaning that some technologies that were not created for classroom use could be implemented in classrooms, given the know-how of teachers. For example, texting was not created to be used in a classroom setting; however, if used properly, it could be utilized as a communication device between teachers and students in and outside the classroom.

Knowledge of teaching with technology among university faculty has been deduced in research to being only knowledge of how to use specific technologies. A study conducted by Spotts and Bowman (1995) showed university faculty members have general knowledge of technology such as that related to audio, film, video, and word processing and a small number of faculty members had limited knowledge of spreadsheets, statistics software, email, course management systems, and instructional technologies such as presentation software, multimedia, and distance learning.

To complement that, researchers Summers and Vlosky (2001) found that more than 50% of university faculty members primarily use word processing as their technology of choice. Bulter and Selldom (2002) research indicate university faculty members have knowledge of word processing, but not of instructional technologies. Bulter and Selldom (2001) stated that they most university faculty members are more proficient with older technologies such as chalkboards, overhead projectors, and VCRs.

University Faculty Perceptions, Use of, and Ability to Use Educational Technology

A study conducted by Velasquez-Bryant (2002) revealed teacher attitudes toward educational technology positively correlate to their technology use in the classroom. The attitude of the teachers toward educational technology also explains their familiarity level with different
technologies, depends upon the confidence level that they have about technology use, and is essential for the success of effective technology implementation (Christensen, 1998). In addition, research conducted by Javeri (2003) concluded that teachers who were willing to integrate technology into their classrooms have positive attitudes toward educational technology.

Nevertheless, Kelly (2003) stated that teachers’ attitudes toward technology will increase when they have knowledge about the uses of the technology. Wang’s (2006) research revealed that when university faculty have positive attitudes regarding technology integration and have knowledge of technology, they are more likely to integrate the technologies into their classrooms. Similarly, Summers (2001) found that university faculty who have sufficient information and understanding of instructional technology will integrate technology into their classrooms more often and have positive attitudes about technology integration.

Teachers recognize the importance of educational technology in the teaching and learning cycle (Javeri, 2003; Mueller, 1996). This was evident in 1997, when 85% of university faculty members stated that they found the use of educational technology appealing (Tharp, 1997). However, according to a more recent study, many are unsure about their ability to use educational technologies in their respective classrooms (Wang, 2006). This was evident in research conducted by Hsu (2003), who found that 75.32% of university faculty members reported that they had knowledge of computers and could perform basic computer tasks such as installing software programs, storing and retrieving data, formatting disks, and performing printing. In the same research conclusion, the author noted that 41.40% of university faculty could evaluate and integrate technology into their curricula and 42.34% of them could effectively integrate technology into their classrooms; however, it was noted that 56.70% of the university
faculty members stated they could did not have the ability or knowledge to implement advanced technologies such as multimedia or telecommunication into their classrooms.

Moreover, Adedoyin and Oluwayomi (2010) research results reveled majority of the teacher educators lack minimum skills, ability, and experiences to make use of technology for teaching and learning in their pre-service classrooms. Further the researchers noted that “the only knowledge and experience most of them had was on general use of computers and word processing packages” (p. 9). By the same token, a study conducted by Snider (2002), a teacher educator at the Texas Women’s University, reveled the lacked of technology integration at the university level in teacher education is due to faculty inexperience.

Technology in Teacher Education Mandates

The reform and restructuring of teacher education to include an educational technology component was first introduced in reports released by the Carnegie Forum on Education and the Economy and the Holmes Group in the late 1980s (Office of Technology Assessment, 1989). As a direct result of that, the American Association of Colleges for Teacher Education (AACTE) and the Association for Teacher Education formulated a list of technological skills and knowledge needed by new teachers (NCATE, 1996; U.S Congress, 1995).

Despite the recommended list of technological skills and knowledge that new teachers are expected to possess, once they complete their teacher training, many still lack such skills and knowledge (NCATE, 1996; U.S Congress, 1995). As a result, federal assistance was initiated to support universities in their efforts to provide technology training to pre-service teachers (NCATE, 1996; Thomas et al., 1997).

The National Council for Accreditation of Teacher Education (NCATE) which is the sole national teacher education accreditation organization in 1988 adopted technological standards for
teacher education preparation programs called “Pedagogical Studies for Initial Teacher Preparation”. Included in it are items such as the requirement for teacher education faculty to use instruction that reflects knowledge, to use various instructional strategies and technologies, and a requirement that faculty model the integration of computers and technology in their field of expertise (NCATE, 1996). In 1994, 41% of teacher education programs at state approved universities were approved by NCATE; 76% are approved in 2009. To assist universities with the implementation of the NCATE technology standard, NCATE initiated a Task Force on Technology and Teacher Education (NCATE, 1997).

Even with the implementation of the Task Force, much is left unsaid as to why many universities are performing below the technology standard as set forth by NCATE.

Faculty Demographics (Age, Gender, and Rank) as they Relate to Technology Integration

Pelucheete and Rust (2005) stated that faculty member’s demographics such as age, rank, and gender are strongly correlated to their use of technology. A study conducted by Noble (2000) reported instructors at a community college demographics (age, rank, and gender) were significantly associated with their technology use.

Age

Age may be a determining factor that influence whether faculty members use educational technology (Cooper, 2006, p. 331). Wallace’s (2004) findings suggest there is no relationship between age and technology use. However, other researchers, such as Teo, disagree, saying that computer usage is influenced by teacher age (Teo, 2008). A study conducted by Rosseau and Rogers (1998) concluded that there is a negative correlation between age and technology use. Gerlich and Wilson (2005) stated that there is a negative correlation between age and technology use. This is supported by Adams (2003), who stated that there is a correlation between age and
technology use. A study conducted by Rosseau and Roge (2001) found that older teachers were less confident in terms of computer usage than younger ones.

Rank

According to Peluchette and Rust (2005) another demographic that is associated with technology use of faculty members is rank. Rank is defined as the academic hierarchical ranking structure in academia. In general, rank is categorized from lowest to highest as: Adjunct, Instructor, Assistant Professor, Associated Professor, Professor, and Distinguished and/or Endowed Professor. Studies in the past have measured rank by using self-reporting data.

Peluchette and Rust (2005) posit from their study that university faculty at the Assistant Professor or Associated Professor rank can either be progress or hinder the integration of new educational technologies at the university level. Also, researchers concur that tenured professors are unlikely to integrate technology into their classrooms because they may not be compelled or motivated to do so (Peluchette & Rust, 2005; Hill, 2004; Gerlich & Wilson, 2005).

More recent research conducted by Heath (2006) concluded that lower ranking professors such as adjuncts have significantly higher levels of knowledge in reference to educational technologies than higher ranking professors such as tenured professors. Health’s study also concluded that there is no significant difference in terms of technology attitudes between faculty members of different rank.

Research conducted on educational technology indicates university faculty is reluctant to utilize technology in their classrooms for several reasons. Wolcott (1997) suggested that the lack of technology use by faculty members was because their university administrators may not consider time spent on technology as part of the teachers’ tenure and performance reviews.

Accordingly Westney (2000) stated “Promotion and review committees are perplexed by the
challenges of evaluating and assigning meaningful credit for the enormous amount of time spent by faculty on integrating technology into the teaching components of their positions” (p 113).

Gender

According to Cooper (2006) gender is another demographic that influence whether faculty members use educational technology. Male teachers tend to use computers more and are more confident in their ability to do so than female teachers (Markauskaite, 2006). Similarly, a TPACK survey administered to 1,185 pre-service teachers found males to have higher TKs than females (Koh, J. H. L., Chai, C. S., & Tsai, C.C., 2010b). Conversely, Wallace (2004) found that females were more influenced to use technology than males. Studies conducted by Spotts, Bowman, and Mertz (1997) and Spotts and Bowman (1995) revealed that men have higher self-efficacy, knowledge, and expertise in technology than females.

Summary

The review of literature presented in this chapter opened a discussion of the dimensions of the TPACK framework to include a theoretical perception of educational technology, PCK, knowledge of teaching with technology and university faculty perceptions, use, and the capabilities of educational technologies. The chapter also went into detail in terms of presenting research that had been conducted on educational mandates for teacher education and technology use by teacher education faculty. Finally, it was demonstrated how demographics of teacher educators influence their technology integration.

Next, Chapter 3 will present an outline of the method and procedures to be used to gather and analyze the data harvested from the participants regarding their age, rank, and gender and TPACK. Information regarding the details of the survey will also be presented and discussed.
CHAPTER 3

METHODOLOGY

Introduction

The purpose of this study was to determine what relationships exist between the age, rank, and gender of university faculty in teacher education and their TPACK. In Chapter 2, the review of literature presented research about TPACK and other underlying concepts pertaining to this study. The purpose of this chapter is to identify methods used to investigate teacher TPACK and presents information regarding the research design, sample population, research instrumentation, collection of data, specific instrument used, as well as detailed data analysis methods.

As specified in the review of literature, current research about TPACK was centered on the knowledge of pre-service and in-service teachers, excluding the TPACK of teacher educators. To reduce the gap in the literature, the purpose of this quantitative, correlational study was to investigate any relationships between university faculty in teacher education TPACK as defined by the TPACK framework and their demographic information.

Research Questions and Hypotheses

1. What is the relationship between the perceived technological knowledge of university faculty in teacher education and their age, rank, and gender?

   HO 1.1 There will be no relationship between the perceived technological knowledge of university faculty in teacher education and their age, rank, and gender.

2. What is the relationship between the perceived technological content knowledge of university faculty in teacher education and their age, rank, and gender?
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3. What is the relationship between the perceived technological pedagogical knowledge of university faculty in teacher education and their age, rank, and gender?

HO 3.1 There will be no relationship between the perceived technological pedagogical knowledge of university faculty in teacher education and their age, rank, and gender.

4. What is the relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?

HO 4.1 There will be no relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender.

Participants

This study included a convenience sampling of faculty in teacher education at 76 Texas public universities. The teacher educators’ area of emphasis may possibly be mathematics, science, social studies, English, Educational Technology, or Curriculum and Instruction. The faculty rank could consist of adjunct, instructor, visiting instructor, assistant professor, associated professor, and professor.

Research Methodology and Design

A research methodology is a theoretical approach involving how research questions should be analyzed. The quantitative approach will be used for this study. According to Creswell
quantitative methodology is optimal when specific factors either influence an outcome or are used to test a theory or explanation. In this study, the teacher educators’ age, rank, and gender used to test whether or not they influence university faculty in teacher education TPACK according to the TPACK framework.

A specific quantitative approach, the correlational method, was used to test the research question hypotheses. Gay, Mills, and Airasian (2006) asserted that the correlational method consist of procedures that collect data “in order to determine whether, and to what degree, a relationship exists between two or more quantifiable variables” (p. 11). In this study, *correlations* used to identify any relationship between the demographic information (independent variable) and the TPACK constructs (dependent variables) of university faculty in teacher education. The dependent and independent variables are listed in Table 3.1. A more detailed list of the research variables is in Appendix A.

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<tr>
<th>Dependent Variables:</th>
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<td>Technology Knowledge (<em>TK</em>)</td>
<td>Gender</td>
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<tr>
<td>Technological Pedagogical Knowledge (<em>TPK</em>)</td>
<td>Age</td>
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<tr>
<td>Technological Content Knowledge (<em>TCK</em>)</td>
<td>Rank</td>
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<tr>
<td>Technological Pedagogical Content Knowledge (TPACK)</td>
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Data was collected using an online self-report survey instrument. The use Internet to conduct research has become popular due to its accessibility to both ordinary and computer-savvy individuals (Wellman, 2004), making it the primary tool for conducting survey research for marketing agencies, public polling organizations, governmental offices, and social science researchers (Sills & Song, 2011).
Survey research is used to gather data about people thoughts and behaviors. Most importantly, according to Crewell (2003), surveys allow for rapid gathering of large amounts of data that otherwise may not been accessible using traditional data gathering methods.

The TPACK instrument utilized self-reported data that is complementary to all known TPACK instruments. Even though researchers tend to object to the use of self-reported instruments, all quantitative questionnaire surveys utilize self-reported data. According to Gonyea (2005), self-reported data have been regarded by earlier researchers as a credible source, particularly in psychology, sociology, and medicine. The argument for the credibility of self-reported data rests on two assertions:

1. Self-reporting research instruments have a greater bandwidth and a lower fidelity rate. This is important because objective data have a high fidelity rate but a limited bandwidth (Astin, 1993). For example, standardized testing measures a learner’s ability more accurately but over a limited knowledge base.

2. Self-reporting data may be the only option for collecting data from a particular population as well as the only practical source for gathering time-sensitive or delicate information. Furthermore, they provide a quicker and more efficient response time and are more cost efficient than objective testing (Gonyea, 2005).

Instrumentation

An adaptive version of the Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt, Baran, Thompson, Koehler, Shin, & Mishra, 2009) was used to measure teacher educators’ TPACK. The original Survey of Preservice Teachers' Knowledge of Teaching and Technology is a 58-item self-reporting instrument that measures the perceived knowledge of pre-service teachers’ TPACK by the use of a five-level Likert scale (1-Strongly Disagree; 2-
Disagree; 3- Neither agree nor disagree; 4- Agree; 5- Strongly agree) of the seven TPACK domains (TK, CK, PK, PCK, TCK, TPK TPACK).

Validity

Content validity: Survey of Preservice Teachers' Knowledge of Teaching and Technology was evaluated for content validity by three nationally known researchers who have expertise in TPACK. The instrument displayed the following content validity ratings: 5.14 (TK); 3.67 (PK); 8.50 (CK); 8.33 (TPK); 9.00 (PCK), and 7.88 (TPACK). This indicates that the three experts taken together agreed approximately 60% of the time about the validity of the test items in reference to the TPACK knowledge domains.

Construct validity: The Survey of Preservice Teachers’ Knowledge of Teaching and Technology was evaluated for construct validity. Construct validity ensures according to Cronbach (1984)" that a construct is a way of construing-organizing-what has been observed "(p. 133). This means that Survey of Preservice Teachers' Knowledge of Teaching and Technology construct adequately measures teachers’ TK, CK, PK, PCK, TPK, TCK, and TPACK. Schmidt et al. (2009) conducted a factor-loading analysis to determine the construct validity of the instrument. All of the factor-loading correlations were greater than the recommended value of .30, according to the Handbook of Parametric and Nonparametric Statistical Procedures (Sheskin, 2004).

Reliability

Reliability is the extent to which any measurement tool produces the same results on repeated trials. Simply put, a measurement tool is said to be reliable if it produce scores that are
stable and consistent over time or across raters (Miller, 2009). There are three categories of reliability: equivalence, stability, and internal consistency (homogeneity).

Internal consistency (homogeneity) is the extent to which the test items on the instrument cohesively measure the same construct. Internal consistency is measured using many notable statistical computations, but the most commonly used computation is the coefficient alpha (Cronbach, 1951). The coefficient alpha is used during scale development with items that have several response options (i.e., 1=strongly disagree to 5=strongly agree). Also, the more test items used to measure a construct, the more reliable the scale is (Gulliksen, 1950).

Reliability alpha values of .70 or higher are considered fitting into the general convention as prescribed by Nunnally and Bernstein (1994). Table 3 presents the internal consistency of the Survey of Preservice Teachers' Knowledge of Teaching and Technology. Table 3.2 presents the internal consistency of the survey as prescribed by Nunnally and Bernstein (1994).

Table 3.2

Survey of Preservice Teachers' Knowledge of Teaching and Technology  Reliability Results

<table>
<thead>
<tr>
<th>TPACK Domain</th>
<th>Internal Consistency (alpha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Knowledge (TK)</td>
<td>.82</td>
</tr>
<tr>
<td>Content Knowledge (CK)</td>
<td></td>
</tr>
<tr>
<td>Social Studies</td>
<td>.82</td>
</tr>
<tr>
<td>Mathematics</td>
<td>.83</td>
</tr>
<tr>
<td>Science</td>
<td>.78</td>
</tr>
<tr>
<td>Literacy</td>
<td>.83</td>
</tr>
<tr>
<td>Pedagogy Knowledge</td>
<td>.84</td>
</tr>
<tr>
<td>Pedagogical Content Knowledge (PCK)</td>
<td>.85</td>
</tr>
<tr>
<td>Technological Pedagogical Knowledge (TPK)</td>
<td>.86</td>
</tr>
</tbody>
</table>
Technological Content Knowledge (TCK)  .80
Technological Pedagogical Content Knowledge (TPACK)  .92

Note: Reliability of the Scores from Schmidt et al. (2009)

Lastly, the Survey of Preservice Teachers' Knowledge of Teaching and Technology from Schmidt et al. was selected for this study even though it was created to investigate the TPACK constructs of pre-service teachers because of the recommendation of the developer of the instrument, Dr. Denise Schmidt. She stated that the survey instrument could be used to investigate the TPACK of university faculty because of the general nature of the instrument. However, Dr. Schmidt stated that researchers should bear in mind the fact that the content knowledge (CK) of the instrument is general in nature. With regard to the primary focus is the technology constructs of TPACK thus the content constructs as well as the pedagogy constructs of the TPACK survey was deleted from the survey. In addition, Dr. Schmidt suggested removing the knowledge label from the survey so that participants would not be made aware of them. The labels were removed in the online version of the survey the participants completed by remained in the paper version. Table 3.3 lists the changes made to the Survey of Preservice Teachers’ Knowledge of Teaching and Technology. The instrument that used in this study is named the Survey of Teacher Educators’ Technological Pedagogical Content Knowledge (TPACK).
<table>
<thead>
<tr>
<th>Original version</th>
<th>Revised version</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CK (Content Knowledge)</strong></td>
<td>Deleted</td>
</tr>
<tr>
<td><strong>PCK (Pedagogical Content Knowledge)</strong></td>
<td>Deleted</td>
</tr>
<tr>
<td><strong>TCK (Technological Content Knowledge)</strong></td>
<td></td>
</tr>
<tr>
<td>“I know about technologies that I can use for understanding and doing mathematics, social studies, science, and literacy”</td>
<td>“I know about technologies that I can use for understanding and doing my content”.</td>
</tr>
<tr>
<td><strong>TPK (Technological Pedagogical Knowledge)</strong></td>
<td></td>
</tr>
<tr>
<td>“My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom”</td>
<td>“My prior educational teaching experience has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom”.</td>
</tr>
<tr>
<td>“I can adapt the use of the technologies that I am learning about to different teaching activities”</td>
<td>“I can adapt the use of the technologies that I have knowledge of for different teaching activities”.</td>
</tr>
<tr>
<td>“I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom”</td>
<td>“I can use strategies that combine content, technologies and teaching approaches in my classroom”.</td>
</tr>
<tr>
<td><strong>TPACK (Technology Pedagogy and Content Knowledge)</strong></td>
<td></td>
</tr>
<tr>
<td>“I can teach lessons that appropriately combine mathematics, social studies, science and literacy, technologies and teaching approaches”</td>
<td>“I can teach lessons that appropriately combine my content area, technologies and teaching approaches”.</td>
</tr>
</tbody>
</table>
The Survey of Teacher Educators’ Technological Pedagogical Content Knowledge (TPACK) instrument contains two sections: Part 1 included 15 items dedicated to collecting demographic information; Part 2 had 16 TPACK items.

Data Collection

The participants were contacted via email December 2012 for their consent to participate in the study. In addition, they were provided with a survey link within the same email message. The survey was administered using Qualtrics software. Participants had a two-week timeframe in which to complete the survey. A follow up email was sent January 2013.

Data Analysis

This study used a correlational research design to analyze the data. Correlational research designs assume that reality is described as a network of interacting and mutually causal relationships (Davis, 2009). The correlational analyses that were used to determine the nature of relationships between the teacher educators’ age, rank, and gender and TPACK was multiple regressions analysis and discriminant analysis. Four parts of the analysis were performed: data assessment, descriptive analysis, test of significance, test of the nature of the statistically significance relationships.

Assessment of the data included an examination of the data set to make decisions on outliers and missing data, to determine if the data is a normal distribution, and to determine the scale reliability and validity. Also the mean average of the TK, TPK, TCK, and TPACK was calculated and entered into the multiple regressions analysis.

The descriptive analysis included a description of the sample population and the mean and standard deviation of the TK, TCK, TPK, and TPACK variables.
The multiple regression analysis was used to test for significance of the relationships between the age, rank, and gender of university teacher educators and their TK, TCK, TPK, and TPACK. Multiple regressions is based on general linear model (GLM) analysis and used to determine the magnitude of the relationship between a criterion (dependent) variable and a combination of two or more predictor (independent) variables (Gall, Gall, & Borg, 2003). The alpha level, or level of significance, was set at .05. Doing so will be consistent with most research studies and signifies the value of an unlikely sample outcome if the null hypothesis is true.

Discriminant analysis was used to determine the nature of the statistically significance relationship(s). Specifically, the discriminant analysis examined the relationship between the criterion dependent variable (technology knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK)) through linear groupings of the predictive independent variables (age, rank, and gender) (Howell, 2002).

Summary

In this chapter, the participants of this study were described as teacher educators at 76 public universities in Texas. The teacher educators were administered the Survey of Teacher Educators’ Technological Pedagogical Content Knowledge (TPACK), which was a slightly modified version of the Survey of Preservice Teachers' Knowledge of Teaching and Technology that was developed by Schmidt et al. in 2009 using a Web-base survey instrument called Qualtrics during the fall 2012 semester. Multiple regression and discriminant analysis was used to analyze the data.
The goal of this chapter was to outline the methods and procedures used to gather and analyze the university teacher education faculty information regarding their age, rank, and gender and their TPACK.
CHAPTER 4

RESULTS

Introduction

The purpose of this study is to determine what relationships exist between the age, rank, and gender of university faculty in teacher education and their TPACK. Chapter 3 outlined the methods and procedures for gathering and analyzing the data from participants regarding their age, rank, gender, and their TPACK.

To determine whether relationships were evident among age, rank, and gender and TPACK, Chapter 4 will begin by presenting the data assessment technicalities involved to ensure the data collected are noteworthy to further conduct the analysis. Next, descriptive statistics gathered from study participants, will be highlighted. The last section of this chapter will display the specific results obtained using multiple regression analysis and discriminant analysis. Specifically, the multiple regressions will determine if relationships exist among the teacher educators’ age, rank, and gender; the discriminant analysis will identify any relationships that were found to be statistically significant.

Research Questions and Hypotheses

1. What is the relationship between the perceived technological knowledge of university faculty in teacher education and their age, rank, and gender?

   HO 1.1 There will be no relationship between the perceived technological knowledge of university faculty in teacher education and their age, rank, and gender.

2. What is the relationship between the perceived technological content knowledge of university faculty in teacher education and their age, rank, and gender?
HO 2.1 There will be no relationship between the perceived technological content knowledge of university faculty in teacher education and their age, rank, and gender.

3. What is the relationship between the perceived technological pedagogical knowledge of university faculty in teacher education and their age, rank, and gender?

HO 3.1 There will be no relationship between the perceived technological pedagogical knowledge of university faculty in teacher education and their age, rank, and gender.

4. What is the relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?

HO 4.1 There will be no relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?

Data Assessment

Sample Size

There is not a static rule for determining the minimal number of participants needed in a study for the results to be considered reliable. Pedhazur (1997) suggested that when using multiple regressions, the number of participants should be determined by a “participant to variable ratio of 15:1 or 30:1 when generalization is critical” (p. 207). However, Guadagnoli and Velicer’s (1988) review of multiple research studies concluded that the minimal number of participants is more relevant and easier to maintain than a participant-to-variable ratio. They suggested the number of participants that make a study’s results reliable should range from 50 to
Along the same lines of a specific number range of participants, Comfrey and Lee (1992) suggested that “the adequacy of sample size might be evaluated very roughly on the following scale: 50 – very poor; 100 – poor; 200 – fair; 300 – good; 500 – very good; 1,000 or more – excellent” (p. 217).

For this study, 756 teacher educators were contacted via e-mail to ask for their participation in this study, and 347 participated (45% response rate). The participant number of 346 exceeds the recommended size according to the participants-to-variable ratio. Additionally, it is greater than the minimum suggested size of 50 and falls within the “good” category according to Comfrey and Lee (1992); thus, the results of the analyses used in this study should be considered reliable.

Outliers

The data was checked for outliers through examination of the range of data in the data file, as well as a visual examination of the scatter plots. As a result, no outliers were found in the data.

Missing Data

All variables were examined for missing values. Since no more than 5% of the data was missing, and missing data patterns indicated that data were missing at random, missing data values were manually replaced with the mean of the scores from the appropriate variable, as indicated by the descriptive statistics (Tabachnick & Fidell, 2001).

Homoscedasticity, Normality, and Linearity

Homoscedasticity is the assumption the variance of errors is the same among all the independent variables (age, range, and gender). The assumption was tested for each of the multiple regressions through examination of the plot of the standardized residuals (the errors). The results indicated the data were homoscedastic.
Normality of the TPACK variables is evaluated through skewness and kurtosis values. The skewness value quantifies the symmetry of a distribution; the kurtosis value quantifies the flattening or peakedness of a distribution. The values should range between $-2$ and $+2$ to be considered variables as normally distributed. Results of the evaluations on the study variables for TPACK have a range between 0.198 and 1.301 (Table 4.1). In addition, a visual examination of the Normal Q–Q plot provided a graphical representation of the normality of the data. The results indicate the data were normally distributed. To determine whether the data was linear, a visual examination of the observed versus predicted values plot was performed. The results indicate the data were linear.

Multicollinearity and Singularity

Multicollinearity is a condition when the independent variables are highly correlated ($> .90$). Singularity is when the independent variables are perfectly correlated, and one independent variable is a combination of one or more of the other independents. These conditions have the potential to weaken a regression analysis by causing the matrix transformations to become unstable. Correlating the independent variables is a method used to test for multicollinearity and singularity. The correlations must be $< .70$ for these conditions not to exist. The results indicate the data were neither multicollinear nor singular.
Table 4.1

Descriptive Statistics of TPACK Variables to include Kurtosis and Skewness

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>STD</th>
<th>Kurtosis</th>
<th>Skewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>TK</td>
<td>3.6901</td>
<td>.74623</td>
<td>-.463</td>
<td>-.198</td>
</tr>
<tr>
<td>TCK</td>
<td>4.1230</td>
<td>.63276</td>
<td>.780</td>
<td>-.695</td>
</tr>
<tr>
<td>TPK</td>
<td>4.0879</td>
<td>.65445</td>
<td>1.301</td>
<td>-.744</td>
</tr>
<tr>
<td>TPACK</td>
<td>3.9903</td>
<td>.72574</td>
<td>.598</td>
<td>-.620</td>
</tr>
</tbody>
</table>

Scale Reliability

The reliability of the Survey of Teacher Educators’ Technological Pedagogical Content Knowledge (TPACK) instrument were conducted using a measure of internal consistency called Cronbach’s alpha. Alpha coefficients range in value from 0 to 1 and describe the reliability data underlying the TPACK factors. The higher the alpha, the more reliable the TPACK scores.

Cronbach (1970) suggested an acceptable coefficient alpha range of 0.7–0.8. The coefficient alpha for all 16 TPACK collective items calculated a score of 0.939, interpreted as the survey being 93.9% reliable. The coefficient alpha for each domain of the TPACK was also calculated. The TK domain coefficient alpha was calculated at 0.887 (88.7% reliable) for the six items within the domain. The TCK domain coefficient alpha was calculated at 0.769 (76.9% reliable) for the three items within the domain. The TPK domain coefficient alpha was calculated at 0.875 (87.5% reliable) for the four items within the domain. The TPACK domain coefficient alpha was calculated at 0.780 (78% reliable) for the three items within the domain. The results are shown in Table 4.2.
Table 4.2
*Cronbach’s Alpha for the Survey of Teacher Educators’ Technological Pedagogical Content Knowledge (TPACK)*

<table>
<thead>
<tr>
<th>TPACK Domains</th>
<th>Score</th>
<th>No. of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>TK</td>
<td>.887</td>
<td>6</td>
</tr>
<tr>
<td>TCK</td>
<td>.769</td>
<td>3</td>
</tr>
<tr>
<td>TPK</td>
<td>.875</td>
<td>4</td>
</tr>
<tr>
<td>TPACK</td>
<td>.780</td>
<td>3</td>
</tr>
<tr>
<td>Totals</td>
<td>.939</td>
<td>16</td>
</tr>
</tbody>
</table>

Construct Validity

The construct validity purpose is to determine whether the Survey of Teacher Educators’ Technological Pedagogical Content Knowledge (TPACK) measured the TPACK domains—specifically the TK, TCK, TPK, and TPACK—as it should. Factor analysis was used to determine the construct validity of the Survey of Teacher Educators’ Technological Pedagogical Content Knowledge (TPACK). The factor analysis technique determined whether the items in an instrument are adequate to gather data pertaining to the construct. The statistical components of the factor analysis used to determine construct validity is the Bartlett test of sphericity (Table 4.3), Kaiser-Meyer-Olkin (KMO) (Table 4.3), Scree plot (Figure 4.1), and the rotated component matrix (Table 4.4).

The Bartlett’s test of sphericity examined the hypothesis that the variables were uncorrelated in the population; in this case, we rejected the null hypothesis because the variables were uncorrelated given the results of a significant value of .000. The results of the Bartlett’s test of sphericity are shown in Table 4.3.
The Kaiser–Meyer–Olkin (KMO) measure is used to examine the appropriateness of factor analysis. High values—between 0.5 and 1.0—indicate appropriate factor analysis. Values below 0.5 imply that factor analysis may not be appropriate. The result of the KMO (.930) indicated that the factor analysis is appropriate for this study and is shown in Table 4.3.

A Scree plot is a visual representation of the number of factors within an instrument. The point at which the line on the Scree plot becomes horizontal corresponds to the number of factors within the instrument. The result of the Scree plot indicated four factors with the Survey of Teacher Educators’ Technological Pedagogical Content Knowledge (TPACK) that correlated to the four constructs that are the focus of the instrument (TK, TCK, TPK, and TPACK). The result of the scree plot is shown in Figure 4.1.

The rotated component matrix details the grouping of the instrument items into the identified number of constructs. The rotated component matrix indicated the items of the constructs into the different domains (TK, TCK, TPK, and TPACK). For example:

- TCK1: “I can choose technologies that enhance the teaching approaches for a lesson in my content area”;
- TCK2: “I can choose technologies that enhance students’ learning for a lesson in my content area”;
- TPACK2: “I can choose technologies that enhance the content for a lesson”;
- TPACK3: “I can teach lessons that appropriately combine my area of emphasis, technologies, and teaching approaches”;
- TK6: “I have the technical skills I need to use technology”;
- TK2: “I can learn technology easily”;

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• TPK3: “I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn”;

• TPK4: “I can use strategies that combine content, technologies, and teaching approaches in my classroom.”

All these statements are related to the first component, which means they are similar in regard to being able to measure the same construct. The results of the rotated component matrix are shown in Table 4.4. Survey items with the corresponding variable label are shown in Appendix D.

Table 4.3
Kaiser–Meyer–Olkin Measure

| Kaiser–Meyer–Olkin Measure of Sampling Adequacy | .931 |
| Bartlett’s Test of Sphericity | Approx. Chi-Square | 4001.040 |
| | df | 120 |
| | Sig. | .000 |
Figure 4.1. Scree plot.
Table 4.4

Rotated Component Matrix

<table>
<thead>
<tr>
<th>Domain</th>
<th>Component 1</th>
<th>Component 2</th>
<th>Component 3</th>
<th>Component 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCK1</td>
<td>.813</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TCK2</td>
<td>.778</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPACK2</td>
<td>.728</td>
<td>.406</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPACK3</td>
<td>.702</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TK6</td>
<td>.584</td>
<td>.547</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TK3</td>
<td>.758</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TK1</td>
<td>.748</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TK4</td>
<td>.739</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TK2</td>
<td>.424</td>
<td>.713</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TK5</td>
<td>.691</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPK1</td>
<td></td>
<td>.765</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TCK3</td>
<td></td>
<td>.757</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPK2</td>
<td></td>
<td>.739</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPK3</td>
<td>.497</td>
<td>.532</td>
<td>.401</td>
<td></td>
</tr>
<tr>
<td>TPACK1</td>
<td></td>
<td></td>
<td>.811</td>
<td></td>
</tr>
<tr>
<td>TPK4</td>
<td>.441</td>
<td>.490</td>
<td>.568</td>
<td></td>
</tr>
</tbody>
</table>

Descriptive Statistics

The sample for this study consisted of 347 teacher educators from 76 public universities in Texas who responded to the survey (46%). The participants were contacted by e-mail. Initially, 301 participants responded to the survey e-mail, and 46 responded to the follow-up e-mail request. The e-mail addresses of participants were collected from their university websites. The demographics information of participants collected were their age, rank, and gender.
The age group of 51-60 had the highest percentage of participants (36.9%), followed by the age group of 60+ (20.3%). The age group with the least number of participants was the group of 20-30 (2.8%). The highest represented was Associate Professor Tenured (27.8%) followed by Full Professor (19.3%). The rank of Associate Professor Non-Tenured was the least represented (.3%). Of the 347 participants, 214 were female (61.7%) and 133 male (38.3%).

A complete list of the demographic information on the participants and their respective percentages for this study are shown in Tables 4.5 through 4.7.

Table 4.5

<table>
<thead>
<tr>
<th>Participants’ Age (n = 347)</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cum Percent</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–30</td>
<td>10</td>
<td>2.8</td>
<td>2.8</td>
<td>2.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31–40</td>
<td>62</td>
<td>17.9</td>
<td>17.9</td>
<td>20.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41–50</td>
<td>77</td>
<td>22.1</td>
<td>22.1</td>
<td>42.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51–60</td>
<td>128</td>
<td>36.9</td>
<td>36.9</td>
<td>79.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60+</td>
<td>70</td>
<td>20.3</td>
<td>20.3</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>347</td>
<td>100</td>
<td>100</td>
<td>3.54</td>
<td>1.089</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.6

*Participants’ Rank (n = 347)*

<table>
<thead>
<tr>
<th>Title</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cum Percent</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjunct</td>
<td>22</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Professor (Non-Tenured)</td>
<td>57</td>
<td>16.4</td>
<td>16.4</td>
<td>22.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assistant Professor (Tenured)</td>
<td>49</td>
<td>14.1</td>
<td>14.1</td>
<td>36.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associate Professor (Non-Tenured)</td>
<td>11</td>
<td>.3</td>
<td>.3</td>
<td>37.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associate Professor (Tenured)</td>
<td>93</td>
<td>27.8</td>
<td>27.8</td>
<td>64.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full Professor</td>
<td>60</td>
<td>19.3</td>
<td>19.3</td>
<td>84.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecturer</td>
<td>29</td>
<td>8.3</td>
<td>8.3</td>
<td>92.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior Lecturer</td>
<td>3</td>
<td>.8</td>
<td>.8</td>
<td>93.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visiting Professor</td>
<td>4</td>
<td>1.2</td>
<td>1.2</td>
<td>94.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical Assistant Professor</td>
<td>4</td>
<td>1.2</td>
<td>1.2</td>
<td>95.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical Associate Professor</td>
<td>2</td>
<td>.5</td>
<td>.5</td>
<td>96.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical Professor</td>
<td>6</td>
<td>1.7</td>
<td>1.7</td>
<td>97.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>2.1</td>
<td>2.1</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>347</td>
<td>100</td>
<td>100</td>
<td></td>
<td>4.73</td>
<td>2.537</td>
</tr>
</tbody>
</table>
The dependent variables of the study were technology knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPACK). New variables—TKmean, TCKmean, TPKmean, and TPACKmean—were created from the dependent variables using their corresponding means and standard deviations in order to condense the number of variables being entered into the multiple regressions. These new variables were used within the multiple regressions analysis.

The survey used a 5-point rating Likert scale. The mean indicates the average response of the participants. The mean for TK is 3.69, for TCK is 4.12, for TPK is 4.08, and for TPACK is 3.990. The standard deviation indicates how spread out the responses is from the mean. The standard deviation for TK is .746, TCK is .632, for TPK is .654, and TPACK is .725. The descriptive statistics of the constructs—TKmean, TCKmean, TPKmean, and TPACKmean—are shown in Table 4.8.
Table 4.8

*Descriptive Statistics for TK, TCK, TPK, TPACK* \((n = 347)\)

<table>
<thead>
<tr>
<th>Domain</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>TKmean</em></td>
<td>3.690</td>
<td>.746</td>
<td></td>
</tr>
<tr>
<td>TK1</td>
<td>3.38</td>
<td>1.016</td>
<td>347</td>
</tr>
<tr>
<td>TK2</td>
<td>3.89</td>
<td>.882</td>
<td>347</td>
</tr>
<tr>
<td>TK3</td>
<td>3.78</td>
<td>.902</td>
<td>347</td>
</tr>
<tr>
<td>TK4</td>
<td>3.67</td>
<td>.981</td>
<td>347</td>
</tr>
<tr>
<td>TK5</td>
<td>3.54</td>
<td>1.015</td>
<td>347</td>
</tr>
<tr>
<td>TK6</td>
<td>3.88</td>
<td>.782</td>
<td>347</td>
</tr>
<tr>
<td><em>TCKmean</em></td>
<td>4.123</td>
<td>.632</td>
<td></td>
</tr>
<tr>
<td>TCK1</td>
<td>4.18</td>
<td>.682</td>
<td>347</td>
</tr>
<tr>
<td>TCK2</td>
<td>4.16</td>
<td>.702</td>
<td>347</td>
</tr>
<tr>
<td>TCK3</td>
<td>4.03</td>
<td>.894</td>
<td>347</td>
</tr>
<tr>
<td><em>TPKmean</em></td>
<td>4.088</td>
<td>.654</td>
<td></td>
</tr>
<tr>
<td>TPK1</td>
<td>4.08</td>
<td>.841</td>
<td>347</td>
</tr>
<tr>
<td>TPK2</td>
<td>4.06</td>
<td>.721</td>
<td>347</td>
</tr>
<tr>
<td>TPK3</td>
<td>4.06</td>
<td>.769</td>
<td>347</td>
</tr>
<tr>
<td>TPK4</td>
<td>4.16</td>
<td>.732</td>
<td>347</td>
</tr>
<tr>
<td><em>TPACKmean</em></td>
<td>3.990</td>
<td>.725</td>
<td></td>
</tr>
<tr>
<td>TPACK1</td>
<td>3.70</td>
<td>.990</td>
<td>347</td>
</tr>
<tr>
<td>TPACK2</td>
<td>4.13</td>
<td>.722</td>
<td>347</td>
</tr>
<tr>
<td>TPACK3</td>
<td>4.15</td>
<td>.879</td>
<td>347</td>
</tr>
</tbody>
</table>

*Note:* *TKmean, TCKmean, TPKmean, and TPACKmean* are the average mean values and standard deviations of the corresponding construct.
Multiple Regression Analysis

One of the statistical analysis methods used in this study was multiple regressions. A multiple regression analysis is based on the general linear model (GLM). The simplest GLM analysis is the linear regression, which determines the magnitude of the relationship between a criterion (dependent) variable and a combination of two or more predictor (independent) variables (Gall, Gall & Borg, 2003). Mathematically, linear regression analysis will produce an equation that predicts a dependent variable using one or more independent variables. The linear regression equation is:

\[ Y = b_1 X_1 + b_2 X_2 + ... + e \]

In a similar manner as a linear regression, the multiple regressions analysis determines the magnitude of the relationship between a criterion (dependent) variable and a combination of two or more predictor (independent) variables; however, more than one criterion (dependent) variable is needed. The multiple regressions equation is:

\[ Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + \ldots + e \]

The statistics of the multiple regressions of importance in determining the relationship between age, rank, and gender of university teacher educators and their TPACK (TK, TCK, TPK, and TPACK) will be the Pearson \( r \), probability \( p \) value, and effect size \( R^2 \).

The Pearson \( r \) is used to determine the strength (magnitude) and direction of the relationship that exists between two variables. The \( r \) value ranges is between +1 and −1. To be specific, Cohen (1998) has recommended using the following to determine the degree of magnitude between two variables:
The $p$ value indicates how confident you can be that each independent variable has some correlation with the dependent variable. In other words, the $p$ value indicates whether the relationship found in the $r$ is statistically significant. The test of statistical significance is determined by the $F$ value, which is produced by the regression that correlates to a specific $p$ value. When $p > .05$, the relationship is statistically significant.

When results are statistically significant, the effect size $R^2$ can be used to measure the strength of the correlation, sometimes called the *effect* (Gall et al., 2003). Simply, the effect size assesses the underlying theory; that is, how much of the dependent variable can be explained by the independent variables. There is no universal number that would determine an adequate effect size. Cohen (1988) presented benchmarks for effect sizes, noted as follows:

- weak = smaller than 0.1
- moderate = 0.3–0.1
- strong = 0.5–0.3
- large = greater than 0.5

**Question 1 – Hypothesis 1.1**

What is the relationship between the perceived technological knowledge (TK) of university faculty in teacher education and their age, rank, and gender?

**HO 1.1** There will be no relationship between the perceived technological knowledge (TK) of university faculty in teacher education and their age, rank, and gender.
Using multiple regression to assess this relationship, the $F$ value of 6.436 ($df = 3,346$) resulted in a $p$ value of .000, which was a statistically significant result as $p > .05$. The null hypothesis, then, was rejected in this case. Hence, there was a statistically significant relationship between TK and the age, rank, and gender of university faculty in teacher education. The $R^2$ value of .053 and the Adjusted $R^2$ value of .045 indicated the predictor variables (age, rank, and gender) combined to explain 5.3% of the dependent variable (TK) variance. Alongside the results being statistically significant, the effect size of 5.3% may be considered large (Cohen, 1988).

Tables 4.9 and 4.10 indicate the regression summary and analysis of the predictor variables (age, rank, and gender), collectively, on technological knowledge (TK).

Table 4.9

| Regression Summary of Age, Rank, and Gender with Technological Knowledge (TK) |
|---------------------------------|------|------|------|------|------|------|
| SS | df | MS | F | $p$ | $R^2$ | Adj.R$^2$ |
| Regression | 10.268 | 3 | 3.423 | 6.436 | .000$^b$ | .053 | .045 |
| Residual | 182.406 | 343 | | | | | .532 |
| Totals | 192.674 | 346 | | | | | |

Table 4.10

| Regression Analysis for Technological Knowledge (TK) |
|---------------------------------|------|------|
| Predictors | $b$ weights | $p$ |
| Gender | $-.021$ | .799 |
| *Age | $-.119$ | .002 |
| Rank | $-.032$ | .051 |

Note: * indicates statistical significance ($p < .05$).
Table 4.10 provides unstandardized \( b \) weights resulting from the regression analysis. The 
\( b \) weights provided an indication of which predictor variables received credit for explaining the 
dependent variable variance (TK). Based on the information provided for \( b \) weights, age \((- .119)\) 
was found to be the best predictor of a university teacher education faculty member’s 
technological knowledge (TK). According to Cohen (1988) effect size benchmarks the \( r \) between 
age and TK is small and negative (-.206). The rank and gender variables were found not to be 
statistically significant in determining the TK of teacher educators.

Question 2 – Hypothesis 2.1

What is the relationship between the perceived technological content knowledge (TCK) of 
university faculty in teacher education and their age, rank, and gender?

H0 2.1 There will be no relationship between the perceived technological content 
knowledge (TCK) of university faculty in teacher education and their age, rank, and gender.

Using multiple regression to assess this relationship, the \( F \) value of 0.238 \( (df = 3, 346) \) 
resulted in a \( p \) value of 0.870, which was not a statistically significant result as \( p > .05 \). I fail to 
reject the null hypothesis; that is, there was not a statistically significant relationship between 
age, rank, and gender and TCK. The \( R^2 \) value was 0.002 and the Adjusted \( R^2 \) value was \(-0.007\). 
Thus, the predictor variables (age, rank, and gender) combined to explain a small variance (.2%) 
found in the technological content knowledge (TCK) of the TPACK domain. Tables 4.11 and 
4.12 indicated the regression summary and analysis of the predictor variables (age, rank, and 
gender), collectively, on technological content knowledge (TCK).
Table 4.11
Regression Summary of Age, Rank, and Gender with Technological Content Knowledge (TCK)

<table>
<thead>
<tr>
<th></th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>R²</th>
<th>Adj.R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>.288</td>
<td>3</td>
<td>.096</td>
<td>.238</td>
<td>.870</td>
<td>.002</td>
<td>−.007</td>
</tr>
<tr>
<td>Residual</td>
<td>138.244</td>
<td>343</td>
<td>.403</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>138.532</td>
<td>346</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.12
Regression Analysis for Technological Content Knowledge (TCK)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>b weights</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>−.031</td>
<td>.658</td>
</tr>
<tr>
<td>Age</td>
<td>−.012</td>
<td>.727</td>
</tr>
<tr>
<td>Rank</td>
<td>−.007</td>
<td>.608</td>
</tr>
</tbody>
</table>

Note: * indicates statistical significance (p < .05).

Table 4.12 provided unstandardized b weights results from the regression analysis. The b weights provided an indication of which predictor variables received credit for explaining the dependent variable variance (TCK). However age, rank, and gender did not result in statistically significant b weights associated with TCK.

Question 3 – Hypothesis 3.1
What is the relationship between the perceived technological pedagogical knowledge (TPK) of university faculty in teacher education and their age, rank, and gender?

HO 3.1 There will be no relationship between the perceived technological pedagogical knowledge (TPK) of university faculty in teacher education and their age, rank, and gender.
Using multiple regression to assess this relationship, the $F$ value of 1.376 ($df = 3, 346$) resulted in a $p$ value of .250, which was not a statistically significant result as $p > .05$. I fail to reject the null hypothesis; that is, there was not a statistically significant relationship between age, rank, and gender and TPK. The $R^2$ value was 0.012 and the Adjusted $R^2$ value was 0.003. Thus, the predictor variables (age, rank, and gender) combined to explain a small variance (1.2%) found in the technological pedagogical knowledge (TPK) of the TPACK domain.

Although results were not statistically significant, the effect size of 1.2% may be considered small (Cohen, 1988). Tables 4.13 and 4.14 indicated the regression summary and analysis of the predictor variables (age, rank, and gender), collectively, on technological pedagogical knowledge (TPK).

Table 4.13
Regression Summary of Age, Rank, & Gender with Technological Pedagogical Knowledge (TPK)

<table>
<thead>
<tr>
<th></th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>$p$</th>
<th>$R^2$</th>
<th>Adj.R$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1.762</td>
<td>3</td>
<td>.587</td>
<td>1.376</td>
<td>.250</td>
<td>.012</td>
<td>.003</td>
</tr>
<tr>
<td>Residual</td>
<td>146.432</td>
<td>343</td>
<td>.427</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>148.194</td>
<td>346</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.14
Regression Analysis for Technological Pedagogical Knowledge (TPK)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>$b$ weights</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>-.062</td>
<td>.394</td>
</tr>
<tr>
<td>Age</td>
<td>.009</td>
<td>.792</td>
</tr>
<tr>
<td>Rank</td>
<td>-.026</td>
<td>.073</td>
</tr>
</tbody>
</table>

*Note: * indicates statistical significance ($p < .05$).
Table 4.14 provided unstandardized \( b \) weights results from the regression analysis. The \( b \) weights provided an indication of which predictor variables received credit for explaining the dependent variable variance (TPK). However, age, rank, and gender did not result in statistically significant \( b \) weights associated with TPK.

Question 4 – Hypothesis 4.1

What is the relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?

HO 4.1 There will be no relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender.

Using multiple regression to assess this relationship, the \( F \) value of 1.123 (\( df = 3, 346 \)) resulted in a \( p \) value of .340, which was not a statistically significant result as \( p > .05 \). I fail to reject the null hypothesis; that is, there was not a statistically significant relationship between age, rank, and gender and TPACK. The \( R^2 \) value was .010 and the Adjusted \( R^2 \) value was .001. Thus, the predictor variables (age, rank, and gender) combined to explain a small variance (1.0%) found in the technological pedagogical content knowledge (TPACK) of the TPACK domain. Tables 4.15 and 4.16 indicate the regression summary and analysis of the predictor variables (age, rank, and gender), collectively, on technological pedagogical content knowledge (TPACK).
Table 4.15

Regression Summary of Age, Rank, and Gender with Technological Pedagogical Content Knowledge (TPACK)

<table>
<thead>
<tr>
<th></th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>R²</th>
<th>Adj.R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1.773</td>
<td>3</td>
<td>.591</td>
<td>1.123</td>
<td>.340</td>
<td>.010</td>
<td>.001</td>
</tr>
<tr>
<td>Residual</td>
<td>180.464</td>
<td>343</td>
<td>.526</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>182.237</td>
<td>346</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.16

Regression Analysis for Technological Pedagogical Content Knowledge (TPACK)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>b weights</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>−.039</td>
<td>.631</td>
</tr>
<tr>
<td>Age</td>
<td>−.040</td>
<td>.294</td>
</tr>
<tr>
<td>Rank</td>
<td>−.017</td>
<td>.287</td>
</tr>
</tbody>
</table>

*Note:* * indicates statistical significance (p < .05).

Table 4.16 provided unstandardized b weights results from the regression analysis. The b weights provided an indication of which predictor variables received credit for explaining the dependent variable variance (TPACK). However, age, rank, and gender did not result in statistically significant b weights associated with TPACK.

To conclude, the results of the multiple regressions analysis indicated a statistical significant relationship exists between the university faculty age and their technological knowledge. Table 4.17 summarized the relationships found using the multiple regressions analysis.
Table 4.17

*Statistical Significant Relationships Summary*

<table>
<thead>
<tr>
<th>TPACK Knowledge Domain</th>
<th>Age</th>
<th>Rank</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological Knowledge (TK)</td>
<td><em>Yes</em></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Technological Content Knowledge (TCK)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Technological Pedagogical Knowledge (TPK)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Technological Pedagogical Content Knowledge (TPACK)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

*Note:* * indicates a statistically significant relationship exists.

Discriminant Analysis

The statistical analysis method used to identify the relationship that exists between the age of university teacher educators and their technological knowledge is discriminant analysis (DA). It separates the variables of two or more groups to determine how each contributes to the variance (Klecka & Peterson, 1980). DA determined which age groups contributed to the teacher educators’ technological knowledge. This is a two-step process: testing significance of a set of the discriminant functions, and classification.

The first step in discriminant analysis was to test for significance in the data. The result of the significance testing produced results similar to the prior multiple regression analysis, indicating a statistically significant relationship between the age of teacher educators and their technological knowledge. The second step in discriminant analysis was to classify the groups as related to the variance in the dependent variable. The covariance matrix table was used to reveal the relationship between each age group (20–30, 31–40, 41–50, 51–60, and 60+) and the teacher educators’ technological knowledge. The results indicated the educators’ age ranges of 20–30 and 60+ had a greater impact on their technological knowledge. The age ranges of 31–40, 41–50, and 51–60 produced around the same relationship. The classification of the age groups is indicated in the covariance matrix in Table 4.18.
Table 4.18

*Discriminant Analysis Covariance Matrices*

<table>
<thead>
<tr>
<th>Age</th>
<th>TK</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–30</td>
<td>.329</td>
</tr>
<tr>
<td>31–40</td>
<td>.586</td>
</tr>
<tr>
<td>41–50</td>
<td>.609</td>
</tr>
<tr>
<td>51–60</td>
<td>.550</td>
</tr>
<tr>
<td>60+</td>
<td>.365</td>
</tr>
<tr>
<td>Totals</td>
<td>.557</td>
</tr>
</tbody>
</table>

To conclude, the discriminant analysis answered the question of what relationship exists between the age of teacher educators’ and their technological knowledge. The discriminant analysis revealed that the educators in the age range of 20–30 and 60+ have the greatest relationship on university teacher educators’ technological knowledge.

Summary

Chapter 4 presented data and analyses addressing the following research questions:

1. What is the relationship between the perceived technological knowledge (TK) of university faculty in teacher education and their age, rank, and gender?
2. What is the relationship between the perceived technological content knowledge (TCK) of university faculty in teacher education and their age, rank, and gender?
3. What is the relationship between the perceived technological pedagogical knowledge (TPK) of university faculty in teacher education and their age, rank, and gender?
4. What is the relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?
In summary, 347 teacher educators from 76 public universities in Texas participated in the study (46% response rate). The age group of 51-60 had the highest percentage of participants (36.9%), followed by the age group of 60 + (20.3%). The age group with the least number of participants was the group of 20-30 (2.8%). The rank that was highest represented was of Associated Professor Tenured (27.8%) followed by Full Professor (19.3%). The rank of Associate Professor Non-Tenured was the least represented (.3%). Of the 347 participants, 214 were female (61.7%) and 133 male (38.3%).

On average the participants selected “Agreed” to their perceived ability to be perform the survey items pertaining to their technological knowledge (M=3.69, SD=.746), technological content knowledge (M=4.12, SD=.632), technological pedagogical knowledge (M=4.08, SD=.654), and technological pedagogical content knowledge (M=3.990, SD=.725).

No statistically significant results were found regarding the relationship between university teacher educators’ faculty age, rank, and gender and their TCK, TPK, and TPACK. The domains of TCK, TPK, and TPACK produced a relative small effect size. In addition, the b weights produced by the regression were not statistically significant.

A statistical significance was found within the multiple regressions conducted on the relationship between the university teacher educators’ age, rank, and gender and their technological knowledge (TK). TK produced a large effect size of 5.3% of the variance explained within the dependent variable. The predictor variable age accounts for most of the variance on TK, while rank and gender were not statistically significant. The predictor variable age was determined to have a small negative correlation (-.206) to TK which indicate a negative relationship between age and TK. In other words, the results suggest, as age increases, TK decreases and conversely, as age decreases, TK increases.
The discriminant analysis revealed how each age group contributes to the university teacher educators’ technological knowledge. How each age group contributes to TK is determined by how tightly fit the data is around the centroid, indicated by a close to zero centroid value. (Klecka & Peterson, 1980). The results indicate the age group of 60+ and 20–30 contribute the most TK (.365 and .329).

In this chapter, data obtained from participating public Texas university teacher education faculty was analyzed in pursuit of answering the research questions posited. The outcome upon analysis of the data revealed that relationships did exist between the predictor variables studied and their TPACK. The concluding Chapter 5 summarizes the findings of this study, draw conclusions, and offer recommendations for further research.
CHAPTER 5

FINDINGS, DISCUSSION, RECOMMENDATIONS, AND CONCLUSIONS

Introduction

The purpose of this study was to determine what relationships exist between the age, rank, and gender of university faculty in teacher education and their TPACK. Chapter 4 outlined the results of the multiple regressions analysis and discriminant analysis used to determine the relationship between age, rank, and gender and teacher educators’ TPACK. The intent of Chapter 5 is to discuss the findings and to suggest implementations the findings may have on the study of TPACK. In addition, this paper will present recommendations for future research pertaining to TPACK, as well as a research conclusion.

Research Questions and Hypotheses

1. What is the relationship between the perceived technological knowledge of university faculty in teacher education and their age, rank, and gender?

   HO 1.1 There will be no relationship between the perceived technological knowledge of university faculty in teacher education and their age, rank, and gender.

2. What is the relationship between the perceived technological content knowledge of university faculty in teacher education and their age, rank, and gender?

   HO 2.1 There will be no relationship between the perceived technological content knowledge of university faculty in teacher education and their age, rank, and gender.

3. What is the relationship between the perceived technological pedagogical knowledge of university faculty in teacher education and their age, rank, and gender?
HO 3.1 There will be no relationship between the perceived technological pedagogical knowledge of university faculty in teacher education and their age, rank, and gender.

4. What is the relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?

HO 4.1 There will be no relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?

Discussion of Findings

Descriptive Statistics

To determine the relationship between university teacher education faculty’s age, rank, and gender and their TPACK, statistical procedures were implemented. Descriptive statistics involving means and standard deviations of the TK, TCK, TPK, and TPACK were calculated (see Table 4.8).

On average the participants selected “Agreed” to their perceived ability to be perform the survey items pertaining to their technological knowledge (M=3.69, SD= .746), technological content knowledge (M=4.12, SD= .632), technological pedagogical knowledge (M= 4.08, SD = .654), and technological pedagogical content knowledge (M= 3.990, SD= .725). “Agreed” was identified as 4 on a 5-point Likert scale, 1-Strongly Disagree, 2-Disagree, 3-Neither Agree or Disagree, 4-Agree, and 5-Strongly Disagree. To make note, their technological knowledge mean is lower as well as the standard deviation is higher than the other constructs. This may indicate the professors are varied on their perceived ability to perform basic technological
functions such as, “solving their own technical problems”, “can learn technology easily”, “keep up with important new technologies”, “play around with technology”, “have knowledge about different technologies”, and “have the technical skills needed to use technology”.

Inferential Statistics

Multiple regressions were run, which utilized the mean of the TPACK constructs of technological knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) to determine their relationship to university faculty age, rank, and gender. Finally, discriminant analysis was used to specify what age range contributed most to the teacher educators’ technological knowledge.

This study answered four questions: Question 1 asked: “What is the relationship between the perceived technological knowledge (TK) of university faculty in teacher education and their age, rank, and gender?” Question 2 asked: “What is the relationship between the perceived technological content knowledge (TCK) of university faculty in teacher education and their age, rank, and gender?” Question 3 asked: “What is the relationship between the perceived technological pedagogical knowledge (TPK) of university faculty in teacher education and their age, rank, and gender?” Question 4 asked: “What is the relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?”

In sum, the relationships between university faculty in teacher education age, rank, and gender and their technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) are not statistically
significant. Thus, the study fail to reject the null hypothesis that correlates to research Questions 2–4, meaning there is not a relationship.

A statistically significant relationship was found between the perceived technological knowledge (TK) of university faculty in teacher education and their age, Question 1. Specifically, the age ranges 20–30 and 60+ contribute to teacher educators’ technological knowledge. As shown in Table 4.10, the relationship is small and negative; thus, indicating in the case where the educators’ age is lower (in the range of 20–30) their technological knowledge increases. Conversely, as their age increases to 60+, their technological knowledge decreases.

Since there is a gap in the literature related to the TPACK of university faulty, studies pertaining to faculty technology integration were used to correlate the research findings to current literature. This evidence of age contributing technology knowledge aligns with the study of Teo (2008) that indicate computer usage is influenced by teacher age. In addition, the results of this study are aligned to the research findings presented by Rosseau and Rogers (1998) that indicated a negative correlation between age and technology knowledge. Similarly, the results of this study are in line with Rosseau and Roge (2001) that found older teachers were less confident in terms of computer usage than younger ones. Along the same lines, the research results are parallel to a number of studies on age and technological knowledge that suggest younger faculty members have greater technological knowledge (TK) than do those of older age (Gupta, 2006; Linkenheimer, 2005; Oblinger & Hawkins, 2006).

According to Prensky (2001), individuals in this age group (60+) are called “digital immigrants” (p. 2). Prensky stated digital immigrant teachers are “the single biggest problem in education” (p. 2) in regard to technology integration. According to this current research study,
this age group’s resistance to technology integration, in part, is due to their lack of technology knowledge.

This lack may be due to rapidly advancing technology in society and in education that is not in the favor of older teachers. For this reason, digital immigrant teachers were never expected to learning new technologies that could be implemented into the classroom.

Moreover, digital immigrant teachers did not see technology used by their former educators, so their perceptions about the use of technology in the classroom will be distorted—thus hindering them from gaining the necessary technology knowledge. As a consequence, enormous amounts of monies, resources, and training allocated to implement educational technologies into classrooms have been unsuccessful at the university level, which can be seen in the teachings of in-service P–12 teachers.

In the scope of TPACK, technological knowledge (TK) is the foundation for the other constructs within the TPACK framework. For this reason, a teacher cannot expand knowledge they do not have to incorporate into other aspects of their teaching. Explicitly, their lack of technological knowledge will hinder their ability to apply technology to their content and pedagogy. In addition, Becker (2000) stated, “For teachers to implement technology into any new instructional strategy, they must acquire new knowledge about it and then weave this together with the demands of the curriculum, classroom management, and existing instructional skills” (p. 10). That being the case, the results of this study is consistent with previous research on factors that influence technology integration.

In regards to the rank and gender variables in relation to TK according to the beta weights of the multiple regressions, they are not significant in the determining TK. The rank demographic significance may not have been determined due to the large number of ranking
variables. The gender demographic significance may not have been determined due to unknown reasons.

As stated in Chapter 2, TPACK has been accepted as a framework for research in teacher education pertaining to teacher use and knowledge of technology (Mishra & Koehler, 2006; Thompson, 2005). Research studies thus far involving TPACK have explored the importance and development of TPACK among pre-service and in-service teachers as well as strategies for developing TPACK. In 2011, Koehler, Shin, & Mishr conducted research to summarize how TPACK has been measured since 2008. Their research found 44% of research measured TPACK of pre-service teachers, 42% of in-service teachers, 7% of a combination of pre-service and in-service teachers, and 7% of university faculty. The 7% of research on TPACK of university faculty was qualitative research on the development of TPACK. As a result, a gap in the literature exists in the focus on university faculty in teacher education.

The purpose of this study was to determine what relationships exist between the age, rank, and gender of university faculty in teacher education and their TPACK. Given that this research was conducted to seal a gap in the literature, little to no correlation of its inferential statistics results can be made to existing literature. Given the similarity in the participants responses to the survey items, the descriptive statistics suggest additional information about the TCK, TPK, and TPACK of university faculty may exist.

In response to Research Question 2, albeit a statistically significant relationship was not found between the perceived technological content knowledge (TCK) of university faculty in teacher education and their age, rank, and gender, the descriptive statistics provided data pertaining to the participants’ perceived technological content knowledge. The TCK mean of 4.12 (SD = .632) indicated, given the five point Likert scale consisting of the answer options of
1-Strongly Disagree, 2-Disagree, 3-Neither Agree or Disagree, 4-Agree, and 5-Strongly Disagree, on average the participants “Agreed” meaning that these candidates possess a fairly high belief in their ability to, “choose technologies that enhance the teaching approaches for a lesson in their content area, choose technologies that enhance students' learning for a lesson in their content area, and to think more deeply about how technology could influence the teaching approaches they use in their classroom.”

In response to Research Question 3, a statistically significant relationship was not found between the perceived technological pedagogical knowledge (TPK) of university faculty in teacher education and their age, rank, and gender. Similar to TCK, the mean for TPK was 4.08 (SD = .654) which indicates on average the participants “Agreed” they could, “thinking critically about how to use technology in their classroom, adapt the use of the technologies that they have knowledge of for different teaching activities, select technologies to use in their classroom that enhance what I teach, how I teach and what students learn, and can use strategies that combine content, and technologies and teaching approaches in their classroom.”

In response to Research Question 4, a statistical significant relationship was not found between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender. Similar to TCK and TPK, the mean for TPACK was 3.99 (SD= .725) which indicated on average the participants “Agreed” they could, “provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at their university, and choose technologies that enhance the content for a lesson, teach lessons that appropriately combine their area of emphasis, technologies and teaching approaches”.

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Due to the average response of the participants are relatively high, to quantify the information generated from the descriptive statistics of the TPK, TCK, and TPACK, a comparison of the means between each group may be analyzed. Further to complement the descriptive statistics classroom observational research must be conducted to explore the nature of the participants’ perceived abilities.

Implications

For Practitioners

This study sought to determine whether a relationship exist between university teacher educators’ age, rank, and gender and their perceived TPACK. The study has implications for educational arena practitioners and programs because the results specify the demographic that statistically impacts a university educators TPACK—their age. This study provide justification for more professional development offerings in the area of technology knowledge for faculty in the age range of 60+; this is in accordance with Mishra and Koehler’s (2006) assertion that teacher training should focus on training teachers how to use the technology.

Moreover, professional development should be provided to all teacher education faculty members early and often, ensuring that their technology knowledge increases with their age in hopes of safeguarding against their unwillingness as they become older.

For Researchers

The study has implications for educational researchers to further investigate the age demographic as it relate to TPACK. In particular, a narrow focus needs to be placed on the specific age groups. For example, research should be conducted using smaller and equal number groups, such as 20-25, 26-30, 60-65, and 66-70.
Lastly, research should be conducted on universities that are providing technology training to their faculty to identify best training practices.

Recommendations

Although this study added to the research on TPACK, the emphasis of university teacher educators TPACK remains relatively new, providing a widespread opportunity for research in this area. In order to build on this body of research, there are topics worthy of future study. For example the investigation of other demographic of university faculty that would contribute to their TPACK, such as employment status, highest degree earned, years of experience, major area of emphasis, certification area, size of your university, size of undergrad and graduate programs, size of faculty, level of access to technological educational, attended educational technology training, source of your educational technology training.

Based on the results of this study and the review of relevant literature, the list below includes several recommendations that should be considered by universities to ensure their teacher education faculty has adequate technology knowledge, regardless of their age.

1. Universities should implement a technology component to their tenured requirements.
2. A technology skill requirement should be included in job description postings.
3. Technological training should be ongoing, and documentation should be provided to show proof of training.
4. University faculty should show evidence of technology being implemented within their classrooms.
Summary

For this study the following research questions were addressed:

1. What is the relationship between the perceived technological knowledge (TK) of university faculty in teacher education and their age, rank, and gender?

2. What is the relationship between the perceived technological content knowledge (TCK) of university faculty in teacher education and their age, rank, and gender?

3. What is the relationship between the perceived technological pedagogical knowledge (TPK) of university faculty in teacher education and their age, rank, and gender?

4. What is the relationship between the perceived technological pedagogical content knowledge (TPACK) of university faculty in teacher education and their age, rank, and gender?

Multiple regressions analysis and discriminant analysis was utilized to indicate what relationships exist between the independent variables (age, rank, and gender) and the dependent variables (TK, TCK, TPK, and TPACK). When considering the effect size and practical significance, the overall results of this study revealed a significant negative correlation in the technology knowledge of the university faculty and their age. The study also revealed that, considering the effect size and practical significance, relationships do not exist between the age, gender, and rank and their technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK).

In the scope of TPACK, the technological knowledge (TK) domain is the foundation for the other constructs within the TPACK framework. That is the knowledge of simple technologies will lend to the use of the technologies in their classrooms (Misher and Kholer, 2006). The results of this study revealed a correlation in the technological knowledge (TK) of the university
teacher education faculty and not in the technological pedagogical knowledge (TPK), technological content knowledge (TCK), or technological pedagogical content knowledge (TPACK). However, higher mean values in the TCK, TPK, and TPACK than TK suggest faculty have a high perception of their technology ability and not so much in their technology knowledge (see Table 4.8).

Thus the findings of this study suggest the problem lies within the indirect correlation of faculty technology knowledge (TK) and their age. Therefore the hope is that this research will add to the current body of literature on TPACK to emphasis the importance of technological knowledge of university teacher education faculty.
APPENDIX A

DETAILED LIST OF RESEARCH VARIABLES
<table>
<thead>
<tr>
<th>Dependent Variables:</th>
<th>Independent Variables:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Knowledge ($TK$)</td>
<td>Gender (Female, Male, Other)</td>
</tr>
<tr>
<td>Technological Pedagogical Knowledge ($TPK$)</td>
<td>Age (20-30, 31-40, 41-50, 51-60, over 60)</td>
</tr>
<tr>
<td>Technological Content Knowledge ($TCK$)</td>
<td>Rank (Adjunct, Assistant Professor (non-tenured), Assistant Professor (tenured), Associated Professor (non-tenured), Associated Professor (tenured), Full Professor, Lecture, Senior Lecture, Clinical Professor, Clinical Assistant Professor, Clinical Associate Professor, Visiting Professor, Other)</td>
</tr>
<tr>
<td>Technological Pedagogical Content Knowledge (TPACK)</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B

EMAIL CONSENT NOTICE
Dear Colleague,

I am writing to request your participation in a research study which I am conducting as a part of my dissertation for my doctorate degree at The University of North Texas. This study will utilize quantitative research methods to examine the relationships among the technological pedagogical content knowledge and demographics information of university teacher education faculty. Specifically, I will explore the perceived technological knowledge, technological content knowledge, and technological pedagogical knowledge domains of the technological pedagogical content knowledge framework. The goal of this study will add to the body of literature that focuses on identifying factors that may influence technology integration at the university level by faculty in teacher education.

The study will focus on the following questions.

1. Is there a relationship between the perceived technological knowledge of university faculty in teacher education and their demographics information?
2. Is there a relationship between the perceived technological content knowledge of university faculty in teacher education and their demographics information?
3. Is there a relationship between the perceived technological pedagogical knowledge of university faculty in teacher education and their demographics information?
4. Is there a relationship between the perceived technological pedagogical content knowledge of university faculty in teacher education and their demographics information?

You are being invited to participate because you have been identified as a Texas public university faculty member in teacher education. If you are not currently a university teacher education faculty member in Texas, please send me a return email at nsbay0405@gmail.com so that I can remove your name from the list.

While we encourage you to participate so that we can have a complete picture of the technological pedagogical content knowledge of university teacher educators, your participation is voluntary and you may choose to end your participation at any time. In addition, your answers on the survey will be confidential and there are no foreseeable risks to you for your participation in the study. The researcher will have access to the key that links participant information to their coded responses; that key will be destroyed once data collection is complete. No identifying information will be included in any dissemination of data. Data will be reported in the aggregate and not attributed directly to one person. The survey will take less than 10 minutes to complete. This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). Contact the UNT IRB at 940-565-3940 with any questions regarding your rights as a research subject.

The survey is available online at the link listed below.
http://untbusiness.qualtrics.com/SE/?SID=SV_6Qk53xyxpy3dvCd

If you would prefer a hard copy of the survey, please email Christina Hamilton at (nsbay0405@hotmail.com), and one will be emailed to you.

Your participation in the survey confirms that you have read all of the above and that you agree to all of the following:

- Christina Hamilton has explained the study to you and you have had an opportunity to contact him/her with any questions about the study. You have been informed of the possible benefits and the potential risks of the study.
- You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your participation at any time.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as a research participant and you voluntarily consent to participate in this study.
- You understand you may print a copy of this form for your records.

If you have questions about this study, please contact Christina Hamilton at 469-644-3729 or email me at nsbay0405@hotmail.com. The faculty sponsor for this study is Dr. Jamaal Young, UNT Professor for the Department of Teacher Education and Administration. Contact information for Dr. Jamaal Young is 940-565-4632 or jamaal.young@unt.edu.

Thank you,

Christina Hamilton

(Principal Investigator)

The University of North Texas
APPENDIX C

FOLLOW UP EMAIL CONSENT NOTICE
Dear Colleague,

I am writing to thank you for taking time to complete my dissertation survey. If you have not taken the survey but would like to do so, the survey will remain active until January 15, 2013.

This study will utilize quantitative research methods to examine the relationships among the technological pedagogical content knowledge and demographics information of university teacher education faculty. Specifically, I will explore the perceived technological knowledge, technological content knowledge, and technological pedagogical knowledge domains of the technological pedagogical content knowledge framework. The goal of this study will add to the body of literature that focuses on identifying factors that may influence technology integration at the university level by faculty in teacher education.

The survey will take less than 10 minutes to complete. This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). Contact the UNT IRB at 940-565-3940 with any questions regarding your rights as a research subject.

The survey can be completed using a mobile device to access the link below.

http://untbusiness.qualtrics.com/SE/?SID=SV_6Qk53xyxpy3dvCd

If you would prefer a hard copy of the survey, please email Christina Hamilton at xxx, and one will be emailed to you.

Thank you,

Christina Hamilton

(Principal Investigator)

The University of North Texas
APPENDIX D

SURVEY OF TEACHER EDUCATORS’ TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK) ITEM VARIABLE NAME
<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What is your gender?</td>
<td>Gender</td>
</tr>
<tr>
<td>Male</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>2. What is your present age?</td>
<td>Age</td>
</tr>
<tr>
<td>20-30</td>
<td></td>
</tr>
<tr>
<td>31-40</td>
<td></td>
</tr>
<tr>
<td>41-50</td>
<td></td>
</tr>
<tr>
<td>51-60</td>
<td></td>
</tr>
<tr>
<td>60+</td>
<td></td>
</tr>
<tr>
<td>3. What is your academic rank?</td>
<td>Rank</td>
</tr>
<tr>
<td>Adjunct</td>
<td></td>
</tr>
<tr>
<td>Assistant Professor (non-tenured)</td>
<td></td>
</tr>
<tr>
<td>Assistant Professor (tenured)</td>
<td></td>
</tr>
<tr>
<td>Associate Professor (non-tenured)</td>
<td></td>
</tr>
<tr>
<td>Associate Professor (tenured)</td>
<td></td>
</tr>
<tr>
<td>Full Professor</td>
<td></td>
</tr>
<tr>
<td>Lecturer</td>
<td></td>
</tr>
<tr>
<td>Senior Lecturer</td>
<td></td>
</tr>
<tr>
<td>Visiting Professor</td>
<td></td>
</tr>
<tr>
<td>Clinical Assistant Professor</td>
<td></td>
</tr>
<tr>
<td>Clinical Associate Professor</td>
<td></td>
</tr>
<tr>
<td>Clinical Professor</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>4. I know how to solve my own technical problems.</td>
<td>TK1</td>
</tr>
<tr>
<td>5. I can learn technology easily.</td>
<td>TK2</td>
</tr>
<tr>
<td>6. I keep up with important new technologies.</td>
<td>TK3</td>
</tr>
<tr>
<td>7. I frequently play around the technology.</td>
<td>TK4</td>
</tr>
<tr>
<td>8. I know about a lot of different technologies.</td>
<td>TK5</td>
</tr>
<tr>
<td>9. I have the technical skills I need to use technology.</td>
<td>TK6</td>
</tr>
<tr>
<td>10. I can choose technologies that enhance the teaching approaches for a lesson in my content area.</td>
<td>TCK1</td>
</tr>
<tr>
<td>11. I can choose technologies that enhance students' learning for a lesson in my content area.</td>
<td>TCK2</td>
</tr>
<tr>
<td>12. My prior educational teaching experience has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.</td>
<td>TCK3</td>
</tr>
<tr>
<td>13. I am thinking critically about how to use technology in my classroom.</td>
<td>TPK1</td>
</tr>
<tr>
<td>14. I can adapt the use of the technologies that I have knowledge of for different teaching activities.</td>
<td>TPK2</td>
</tr>
<tr>
<td>15. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.</td>
<td>TPK3</td>
</tr>
<tr>
<td>16. I can use strategies that combine content, technologies and teaching approaches in my classroom.</td>
<td>TPK4</td>
</tr>
<tr>
<td>17. I can provide leadership in helping others to coordinate</td>
<td>TPACK1</td>
</tr>
</tbody>
</table>
the use of content, technologies and teaching approaches at my university.

<table>
<thead>
<tr>
<th>18. I can choose technologies that enhance the content for a lesson.</th>
<th>TPACK2</th>
</tr>
</thead>
<tbody>
<tr>
<td>19. I can teach lessons that appropriately combine my area of emphasis, technologies and teaching approaches.</td>
<td>TPACK3</td>
</tr>
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</table>
REFERENCES


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Wellman, B. (2004). The three ages of Internet studies: Ten, five, and zero years ago. New Media & Society, 6, 123-129.


