TECH-SAVVY TEACHERS: A CASE STUDY INVESTIGATING THE RELATIONSHIP BETWEEN TEACHERS' PERCEPTIONS OF MOBILE DEVICES, PARTICIPATION IN OPTIONAL PROFESSIONAL DEVELOPMENT, AND APPLICATION USAGE IN CLASSROOMS.

By

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THESIS ABSTRACT

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Title: Tech-Savvy Teachers: A Case Study Investigating the Relationship between Teachers' Perceptions of Mobile Devices, Participation in Optional Professional Development, and Application Usage in Classrooms.

The increase of mobile devices (iPads, tablets) in classroom learning brings excitement to the learning environment. Previous research regarding mobile devices in educational settings focused on new technology's relationship to student engagement. However, it is equally important to understand driving factors in teachers' choices to engage with technology. The current study utilizes the modified Technological Acceptance Model (TAM) as proposed by Sanchez-Prieto et al. (2016). The study validates the proposed scale and analyzes the correlation between engagement with professional development (PD) and the use of the KinderTEK math application in classrooms. An aggregate correlation showed significant results from the mobile anxiety subscale $MA = .874$, $p = .023$. The lower administrators' anxiety scores were, the higher usage of the application in classrooms associated with their schools. Participation in PD was too low to draw any significant conclusion. The current study provides insights into systems of support for teachers utilizing technology.

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CHAPTER I

INTRODUCTION

The majority of research around mobile devices in school settings revolves around increased student engagement. This research focuses on teacher and administrator engagement with resources and the technology in the classroom in an effort to examine adoption through a new lens.

Technology and Mathematics in Schools

Technology utilization and its perceived affordances continues to supplement a desire for integration in schools. Many schools are looking to technology for its innovative instructional opportunities. Research shows quality educational media can have lasting positive effects (Fisch & Truglio, 2001; Jennings, Hooker, & Linebarger, 2009). A large body of work examines the impacts of mobile devices, such as iPads or tablets, in schools. Generally, research shows modest positive effects of instructional technology (Snyder and Dillow, 2013; U.S. Department of Education, 2016a**).** Project Tomorrow, an education nonprofit group from California, found that 47% of K-12 teachers reported their students had access to mobile devices in classes and 68% of teachers used internet-based resources like videos to bolster their classes. They further found that 59% of students reported accessing extra technology-based resources specifically in mathematics (Project Tomorrow 2015; Project Tomorrow 2016). Although Project Tomorrow is not technically a nationally representative survey, the National Science Foundation acknowledges that the robust study likely embodies an extensive sample.

The National Science Foundation released a report regarding Science Technology Engineering and Mathematics (STEM) progress in K-12 public education. In it, the researchers note that the National Assessment of Educational Progress (NAEP) shows mathematics scores in elementary schools declining. Furthermore, in their Early Childhood Longitudinal Study, researchers found that gender gaps in mathematics had not changed since 1999. The researchers further found that many “teachers misperceive girls’ mathematics ability” and that from kindergarten on, the gap worsens every year (National Science Board, 2018, p. 4-26). There is a possibility that the use of mathematics applications can decrease this gap through the use of a platform that should not be subject to gender bias.

The fascination with new technology manifests in many ways, including news reporting and media interest stories. Just over the last few years many articles have been published in mainstream journals about iPads, smartphones, and neurological development, showing a national interest in the subject. This media attention provides an interesting layer to the perception of technology use in classrooms concerning whether or not attitudes are affected by media representations. Media studies pieces propose multiple reasons for user adoption of technology and participation in new systems. McLeod et al. explore the various ways in which popular media not only influences news media but similarly social contexts and perceptions. Hedman and Gempel (2010) explore the influence of ‘hyping’ technology or creating a consumer base from aesthetic and social desirability as opposed to functionality. Toff and Nielsen (2018) continue to show how media context influences social understanding through their exploration of information theories.

Their study finds that massive amounts of information lead many consumers to feel unsure of what to believe. This concept weighs on the perceptions of technology as an educational tool due to a constant stream of contradicting information about the usefulness and detriments of such tech, whether from a popular press or scholarly perspective. Furthermore, once information becomes public, social networking increases the spread of the information, whether true or false (Dong, Fan, & Huang, 2018). These theories acknowledge the ability of popular press to shape both individual and collective ideologies. These mainstream attitudes may also affect subjective norm, or the majority's perception of the tech. If true, this subjective norm would play directly into individual beliefs and intention to use the medium at hand (Fishbein & Ajzen, 1975; Ajzen, 1991; Venkatesh & Davis 2000; Hedman & Gimpel, 2010). Even more specified magazines, such as *Educational Leadership*, dive into the issues of professional development and technology integration, adding yet another layer to the types of information teachers may be receiving and their consequent perceptions about the technologies at hand.

Another critical aspect of understanding learning during pre-school and kindergarten years is considering the age group from a developmental standpoint. A key point of neural development, synaptic pruning, begins around the two-year mark. Synaptic pruning is the process through which children's brains select the pathways most important to them and selectively kill off the excess neurons (apoptosis). The visual and motor cortices are key developers during this pre-school and kindergarten period, while prefrontal pruning continues into adolescence and adulthood (Bjorklund & Causey, 2018).

These developmental markers are important to understand within exposure to technology for learning. It is important to keep these development stages in mind and utilize effective tablet application design to promote rather than demote learning acuity. Understanding the plethora of factors surrounding education practices with technology and the state of mathematics instruction helps set the scene for tackling concepts that can help improve integration in an effort to support both students and teachers.

Purpose of the Study

Most research about mobile devices in the classroom focuses on increased student engagement levels with applications (Couse & Chen, 2010; Kucirkova et al., 2014; Neumann 2018). An important, understudied aspect of healthy technology integration is the views of teachers and their access to professional development opportunities regarding these advances. While the Technological Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) both look at attitudes towards technology relating to integration in many settings, including education (Couse & Chen, 2010; Li et al., 2010; Blackwell et al., 2014, 2014; Sánchez-Prieto et al., 2016; Wu & Chen, 2016), they have not been examined under the lens of optional resource participation, nor have administrators' attitudes and their potential effects on technology usage within a school.

The purpose of this study is to examine attitudes towards technology in classrooms and their relationship to participation in professional development opportunities offered as well as usage of the math application in the classroom. The study focuses on teachers and administrators in the KinderTEK program. KinderTEK is a kindergarten math application that can be used to meet the individual needs of children from grades K-3. It aligns with the Common Core Standards and allows teachers to assign individualized work as well as pull progress reports for each student. The application was created at the University of Oregon by the Teaching and Learning Center. The application has animal avatars and takes children through a series of games to practice their fundamental math skills. While KinderTEK has many different pilot programs, this study focuses on schools participating in the sequenced learning mode in which children must learn and complete tasks to prove they have mastered a concept before moving to a new one. KinderTEK further allows teachers to track and plan based on an individual child's performance. The application was created and tested through federally funded research and has been shown to help children reach their classroom goals in mathematics mastery. This study aims to review and validate the TAM as proposed by Sánchez-Prieto et al. (2016) as well as examine whether the instrument can be applied to choices in optional training and usage of the KinderTEK application in classrooms. The goal of the research is to inform integration practices and understand the systems that influence adoption of technology in elementary school settings in order to provide insights to help teachers and students with mobile devices.

Literature Review

Mobile Device and Educational Application use in Preschool, Kindergarten, and 1st Grade

This section examines relevant, modern scholarly research surrounding the use of applications and mobile devices (iPads, tablets) in school settings. The research highlighted specifically focuses on educational applications for pre-school, kindergarten, and first-grade classrooms in order to give readers an idea of previous work surrounding a similar age set as is observed in this study.

Since mobile devices entered the education field, there has been intrigue about their place in the classroom. Falloon (2013) delves into the intricacies of application design and usefulness in the classroom with his research studying iPads in a classroom of18 five-year-olds and an experienced teacher. Falloon's (2013) study strives to answer the question of what constitutes a high-quality application. His research question specifically is: "How do design and content features of selected apps used on iPads affect the learning pathways of young students using them independently for problem solving tasks?" (Falloon, 2013, p. 506). Taking on a unique and difficult question, Falloon (2013) observed in-person weekly, collected visual and audio data of the children's interactions with the application, and conducted teacher interviews over a six-month period. There were 45 total applications used, each carefully selected by the teacher based on how well the app appeared to match educational goals, feedback from her students, online reviews, ratings, and the cost. 20 of the 45 applications were paid-for versions, and 25 were free. The teacher also requested that wireless internet be disabled during the iPad work sessions in order to prevent the children from being distracted from the task at hand. The applications covered a broad range of topics including literacy, problem solving, and mathematics.

Concerning data collection, Falloon (2013) was careful to create a recording program that was not visible to the participants in an effort to simulate a more "natural" (p. 508) environment of use. Once data was collected, an independent coder blind coded a 4.5-hour sample of interactions to create a framework of student's cognitive processes.

The researcher and the coder had 94% agreement in identification of distinct "learning pathways" (p. 509). These were compiled into four categories of occurrences: whether the application design enabled or distracted from learning, the type of learning the student was doing (declarative/instant knowledge, or procedural/learning to work something out), cognitive effort (perseverance or game-based), and whether the application created competitive or collaborative learning. In regard to the neuroscience of learning, declarative knowledge relates to fact-consumption and memorization ("I know that"), whereas procedural knowledge is the act of knowing how to do something (e.g. problem solving or the act of writing; "I know how"; incremental learning). Falloon's (2013) categories fall in line with these definitions. Once the researcher and the coder created the framework, they applied it to 12 more hours of recordings as well as re-coded the original sample. The final data sample included 16.5 hours, representing 70% of the total recorded data.

Falloon (2013) found that applications that walked students through learning concepts in an organized manner generated more learning responses than game-based applications. Further, the most effective applications closely paired with traditional models of instructions, similar to how a teacher would guide students through a lesson. Falloon's (2013) research further states the importance of effectively communicating guidelines and concepts, modelling, using examples, and prompting questions as teachers do in order for an application to comprehensively promote student learning. These findings highlight the importance of comfort with devices as well as precise integration. This aligns closely with the sequenced mode of the KinderTEK2 program and the importance of building educational concepts through mastery. KinderTEK attempts to fulfill these practices through this mode and the offering of professional development.

Falloon and Khoo (2014) conducted a study surrounding the use of iPads in New Zealand schools. The researchers designed an 'observaware' application to collect data about how five-year-olds interacted with each other while using the iPad for math, reading, and problem-solving skills. The researchers designed the application to record relevant cooperative learning data, such as audio and display information in order to measure engagement and time-on-task. Falloon and Khoo (2014) analyze the data through the lens of Mercer's (1994) three categories of talk. Mercer's (1994) work with students yielded three distinct types of group or pair interactions: disputational (argumentative), cumulative (agreement), and exploratory (reasonable debate and exploration). The researchers are careful to note that in the case of exploratory and cumulative speech interactions one does not necessarily outrank the other. Wanting to keep the application within the realm of an "open design," which encourages students to create their own content or ideas through puzzles instead of a heavily structured design, the researchers used the following applications: Puppet Pals HD, Pic Collage, and Popplet. Puppet Pals HD encourages students to design and narrate stories; Pic Collage allows students to use pictures to create an artistic summary to a prompt; and Popplet is a brainstorming tool that utilizes text, pictures, flowcharts, and drawing to help link concepts together.

The researchers conducting this study wanted to understand which talk types prevailed the most through the use of these applications and how teachers may be able to utilize the information to conduct productive, exploratory discussions between students.

Falloon and Khoo (2014) conducted the study in a New Zealand grade-1 classroom with 19 students. In order to fully understand time-on-task and talk types, the researchers collected not only audio data but also finger placement and screen data. Through their analysis, they found that most of the discussion fell under the category of cumulative, or agreement-based speech. They found that instances of exploratory talk were more often prompted by a teacher than their peer group. The results provide intriguing information about the role of the teacher as a facilitator of investigative speech and debate between children in classrooms with and without mobile devices. These findings align closely with Falloon's (2013) study and demonstrate the importance of comprehension and comfort with devices and applications to promote use. It is important to note the value of effective professional development and instructional supports in bolstering these key factors.

Neumann (2018) took a close look at iPad use for emergent literacy skills in children ranging from two to five years of age. Emergent literacy skills are developed after birth and relate to visual understanding, letter sounds, phonological knowledge, and writing. Neumann (2018) created a literacy intervention with Endless Alphabet, Letter School, and The Draw Buddy applications, which were selected based on criteria outlined by Hillman and Marshall (2009). The criteria included literacy features such as matching, tracing, and drawing letters. Participants were recruited from different daycares in Australia, resulting in a sample of 48 English-speaking children, 25 of whom were boys and 23 of whom were girls. Each child participated in a pre-test of emergent literacy measures including print concepts, letter name and sound knowledge, numeral name knowledge, name writing, and letter writing. The participants were then parsed into an iPad or control group. Over nine weeks, the iPad group received 30 minutes of iPad-based literacy instruction supervised by a qualified school teacher, and the control group participated in other activities such as games or painting. Two weeks after the intervention, children from both groups took a post-test. The results showed a significant gain in letter name and letter sound knowledge as well as name writing. This study shows that mobile devices are effective mediums for learning in early education in relation to a control group and prompts further investigation into multimodal contexts.

Moreno et al. (2018) take an intriguing look into attention restoration and learning practices through app use with their study. Moreno et al. (2018) examine kindergartener attentional recovery strategies by creating an application they believed would support learning in line with the attention restoration theory. The attention restoration theory, or ART, proposes that time spent in nature restores attention after attention depletion because of the effortless, mind-wandering type of attention nature offers (Berman, Jonides, & Kaplan, 2008**).** Moreno et al. (2018) attempt to capture this through the use of "two-minute, non-interactive, high-quality real nature video[s]" (p.7). The researchers intended for the application to be used to improve focus for the following 20-30 minutes of classroom learning. Utilizing principles of guided meditation, the students would watch and listen to the nature clips then be told that their mind felt at ease and they were ready to return to their classroom. The study was conducted over two years, in 16 schools, with 115 K-2 classes, and 2,304 students. The researchers targeted lower socioeconomic status schools for the purpose of this study in order to engage in a more global lens. In order to do this, schools selected to participate had at least 70% free and reduced priced lunch. Ethnicity was well distributed with nine of the sixteen schools averaging 96% African American students, five of the sixteen averaging 81% Latinx, and the remaining two schools containing populations with a 65% average Caucasian enrollment. The researchers used a frequency-of-use analysis to analyze the data. However, the stats showed no significant findings, so the researchers took an exploratory approach. While the data showed little change in improved attention after use, the study presents an interesting theoretical perspective to addressing executive function as well as applicability of application use in K-2 classes. The authors discuss the possibility of improper use of the application as a form of punishment rather than as moderated breaks to refocus students. Factors like these argue for the importance of standardized integration and clear explanation of use to teachers using these devices and applications.

Morgan et al. (2018) examine the effects of executive control deficits of participants in the Early Childhood Longitudinal Study-Kindergarten Cohort of 2011. This massive study (n = 11,010) looks at "achievement growth trajectories in mathematics, reading, and science" through identified executive function (EF) areas such as working memory, cognitive flexibility, and inhibitory control. Working memory is the ability to hold and use information during a short period of time. Cognitive flexibility is being able to shift attention between multiple aspects of a task, such as intaking and processing new information. Inhibitory control is the ability to delay gratification in an effort to finish the task at hand; a common example of this would be the marshmallow test. Inhibitory control is of particular interest at the kindergarten level as children develop these skills. Executive function not only relates to attention and academic achievement but also to socioemotional issues and addictive behaviors.

This study highlights the importance of understanding these effects while children's executive function is at a highly mutable stage in an effort to intervene early. The researchers hypothesized that EF deficits would become a repeated issue throughout concurrent academic years, and that this hypothesis would be true even when accounting for socio-demographic characteristics. They further hypothesized that working memory as a function of EF would be the heaviest predictor of issues when contrasted with the other two functions (cognitive flexibility and inhibitory control). The U.S. Department of Education's National Center for Education Statistics (NCES) maintains this dataset. This ongoing study demonstrates the importance of addressing attentional issues and achievement gaps at a young age. Programs like KinderTEK, which can focus on individual needs and sequenced learning, have the potential to close some of these achievement gaps.

Important research must also be considered from "Foreign-language experience in infancy: Effects of short-term exposure and social interaction on phonetic learning" a study by Kuhl, Tsao, and Liu (2003). This classic neuroscience of language acquisition piece demonstrates important acquirement differences considering language learning and development. In Kuhl et al.'s (2003) study, English-speaking six-month-olds were exposed to Mandarin either through social interaction, video, or audio learning. The researchers found that infants retained phonemic discrimination abilities for the foreign language only through social gating, or classroom-style learning. They measured this discrimination with an infant looking paradigm in order to distinguish foreign language phoneme recognition. In the study, "attention scores for infants in the AV (audio visual) and A (audio only) groups revealed that they visually attended less than infants in the live exposure sessions" (Kuhl et al., 2003, p. 9909). This research shows that developing children appear to learn language from social environments rather than auditory or visual stimulation alone. While this study focuses on infants, the findings continue to call for an integrated approach to learning. This shows the importance of facilitator speech when using iPads for learning in the classroom. Research shows children mimic and respond to learning in social contexts, much like Falloon (2013, 2014) showed in their mobile device studies.

The Technological Acceptance Model (TAM)

This section attempts to outline the history of the Technological Acceptance Model (TAM) from the psychological constructs and theories that support it to its many influences along the way. The section runs through the Theory of Reasoned Action (TRA), the main contributor to the original TAM and then follows the TAM's expansions through the decades to what it has become today. This section hopes to give readers a better understanding of all of the influencing factors relevant to technological acceptance and how the model became the one used in this study.

The study of understanding and predicting actions has taken place over many years. One of the most notable examples in psychology pertaining to the comprehension of people's actions comes from Fishbein and Ajzen's (1975) book, "Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research." The researchers dive into psychological principles guiding belief, attitude, and intention formation. Fishbein and Azjen (1975) lay framework for belief formation explaining the ease and commonality of inferential beliefs. Inferential beliefs are assumptions made based on descriptive observations. An example of an inferential belief would be: Sarah wears glasses; therefore, Sarah is smart. They explain how the establishment of these links creates a litany of associated beliefs (Sarah is smart; therefore, I can rely on Sarah, etc.). This belief sequence is an important aspect of understanding perceptions, as one perception is often associated with many others. Belief formation leads into the determinants of attitude.

Fishbein and Ajzen (1975), explain that the determinants of attitude are based on related belief systems. They define attitude as a favorable or unfavorable view of an object, which can be based on life experience, religion, or a plethora of other associations. A person's attitudes then lead to the formation of an intention, or the person's desire to take an action. Fishbein and Ajzen (1975) explain that intentions have often been lumped under the subcategory of attitudes. Because of this, there is an implication that attitudes and intentions have a strong relation: "The usual assumption is that the more favorable a person's attitude toward some object, the more he will intend to perform positive behaviors (and the less he will intend to perform negative behaviors) with respect to that object" (Fishbein & Ajzen, 1975, p. 288). However, the researchers point out that little evidence exists to support such a claim. They suggest instead that there are two main factors in a person's likelihood to act, which are the person's attitude as well as the perceived subjective norm, or what the general population surrounding the subject believes of the behavior. Figure 1 below shows how a mixture of personal beliefs and attitudes combined with the normative, or perceived standardized beliefs, and subjective norm, or perceived relevant social pressures about behaviors, both affect the intention of the person to perform a behavior and therefore the likelihood that the person will in fact perform the action. The Theory of Reasoned Action (TRA) has come to inform many influential papers since and is the basis on which the Technological Acceptance Model (TAM) was built.

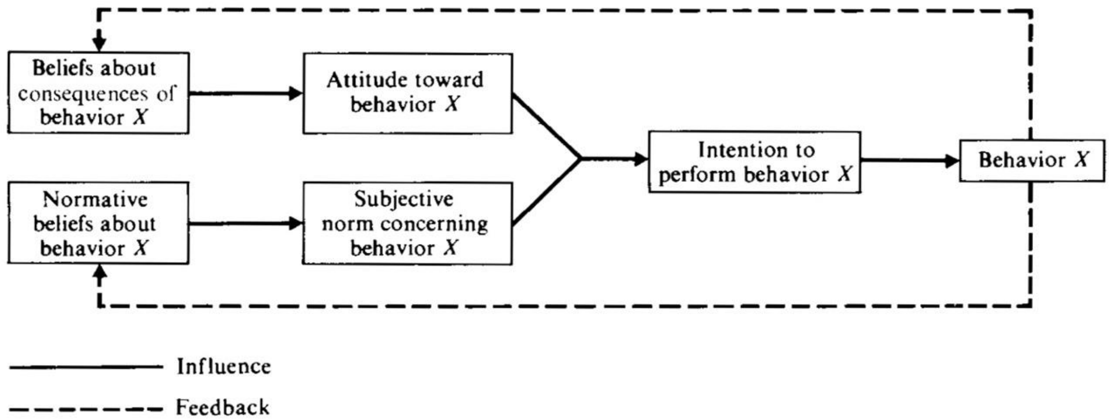


Figure 1. Conceptual Framework for Theory of Reasoned Action (Fishbein & Ajzen, 1975)

The Technological Acceptance Model (TAM) has been a popular instrument to use in areas ranging from business to medical fields in an effort to understand what influences people to accept new technologies in the workplace (Davis, 1989; Adams et al., 1992; Hu et al. 1999). The original TAM only had two subscales, Perceived Usefulness and Perceived Ease of Use, which were based on the psychological principles of the Theory of Reasoned Action (Fishbein and Ajzen, 1975; Davis, 1989). Davis (1989) creates and validates the TAM in his study with International Business Machines (IBM) employees. The study included 152 users and four application programs. The original scale included 14 items in each subscale. However, in order to validate the TAM, Davis (1989) first puts it through a pre-test. 15 experienced technology users from Massachusetts Institute of Technology (MIT) were involved in the pre-test. The participants separated the items by category and scaled the survey down to 10-items for the subsequent studies.

In the first study, Davis (1989) tests reliability and validity. He administers the survey to 120 participants working at IBM Canada's Toronto Development Laboratory. Participants answered the subscales in relation to two technological systems available (electronic mail and file editing) using a seven-point-Likert-scale. The final sample included 112 responses, 10% managers, 35% administrators, and 55% professional staff. Davis (1989) uses this study to test for discriminant and convergent validity as well as reliability. He finds that the subscales show high reliability. Perceived usefulness showed high reliability for both e-mail and file editing software users (a = .97). Perceived ease of use also scored moderately high reliability. Since there were differences between the values in e-mail and the file editing software, observations were pooled for the two systems to give an overall Cronbach's alpha of .91.

Davis' (1989) second study investigates the predictive power of the subscale. The participant pool for Study 2 involved 40 voluntary participants from the Boston University MBA program, who were each compensated with $25 for participating. The pool had an average of five years' work experience and were all employed full-time. In the study, the participants were exposed to two prototype systems. One was Chartmaster, an IBM graphing system to build basic business charts, and the second was Pendraw, a system that used a pen and stylus to create images and manipulate pictures. The participants were given an hour of time to explore and learn the new systems with the accompanying user manuals. The participants were split in half. One grouped worked with Chartmaster first and the other with Pendraw first to eliminate initial use bias. After using each prototype, researchers gave participants the questionnaire. Following the questionnaire, participants were asked to predict their future use of each prototype software.

In study two, the perceived usefulness again achieved high reliability (*a* = .98), as did perceived ease of use (*a* = .94). Davis (1989) ran correlations between the items in each subscale with each prototype and found that omitting question four from ease of use about flexibility and control of the system showed a higher Cronbach's alpha, showing the importance of factor analysis and constant scale revisions when making high-quality scales. Usefulness was significantly correlated with self-predicted usage for Chartmaster ($r = .71$, $p < .001$), but ease of use was not. However, Pendraw showed significant correlations between both usefulness ($r = .59$, $p < .001$), and ease of use ($r = .47$, $p < .001$). When both data sets were pooled, overall correlations between usefulness and use were $r = .85$, $p < .001$, and $r = .59$, $p < .001$ for ease of use. Regression analysis further showed high predictability.

Subsequent studies utilizing this model have shown that if workplace employees see new technology or systems as useful and easy to use, they are more likely to adopt them. Over the following 11 years, the TAM continued to be replicated (Addams et al., 1992; Davis, 1992). Hu et al.'s (1999) study in particular branches out of business and expands global validity with the model, representing an important replication for the scale. This replication was done in telemedicine in China (Hu et al., 1999). Telemedicine is a technological advancement with the potential to improve communication within a healthcare organization. This study looked at physicians in a tertiary, or specialist, hospital in Hong Kong. The research showed high scale validity and reliability. 1,728 questionnaires were distributed to physicians in nine specialties including internal medicine, obstetrics and gynecology, pediatrics, psychiatry, radiology, pathology, accident and emergency, intensive care, and surgery. Of the distributed sample, 24% responded, leaving a sample size of 421. The analysis showed significant causal paths between the scales and intentions to use. Perceived use accounted for 44% of the variance in this study and perceived ease of use accounted for 37%. As Davis (1989) noted in his study, the original TAM as well as subsequent replications dealt mainly with Caucasian middle- to higher- class. Here, Hu et al. (1999) show global validity by applying it to a more diverse population and still receiving similar results. One interesting distinction in Hu et al.'s (1999) study is that perceived ease of use did not significantly affect perceived use. The researchers discuss the possibility that in more difficult professional settings such as the medical field, perceived ease of use may not apply as heavily as the perceived usefulness of a new system. This idea could further suggest the importance of showing the significance of the new technology being implemented especially when a system is difficult to use.

The TAM became so popular and well-replicated in research that multiple new models have been proposed and are in use today (Venkatesh & Davis, 2000; Venkatesh et al. 2003, Venkatesh & Bala, 2008; Sánchez-Prieto et al., 2015). Venkatesh and Davis (2000) make the first official modification of the TAM, creating the TAM2. Their research examines the social and cognitive aspects around adoption of new technology through four longitudinal studies. They explore these factors as an applicable extension of the theoretical framework outlined by Fishbein and Ajzen (1975). They outline the psychological basis for their proposed extension. They hypothesized that subjective norm, or a "'person's perception that most people who are important to him think he should or should not perform the behavior in question'" (Fishbein and Ajzen 1975, p.302), would have a direct effect on the person's intention to adopt the new technology in the mandatory setting, but not the voluntary setting. Their next main factor was image, which they define as "'the degree to which use of an innovation is perceived to enhance one's status in one's social system'" (Moore & Benasat, 1991, p.195). Venkatesh and Davis (2000) relay that typically if workers believe the adoption of a technology will lead to possible upward mobility in the workplace, they will be more likely to adopt it. Therefore, they propose that subjective norm will affect image and then image will affect perceived usefulness (Venkatesh & Davis, 2000, p.189). The next categories Venkatesh and Davis (2000) add to their examination of adoption principals include job relevance, output quality, and result demonstrability (or the ability to see positive results). They propose that job relevance will have a positive effect on perceived usefulness, as will output quality and result demonstrability.

In order to examine their hypotheses, Venkatesh and Davis (2000) created four separate groups. Two were required to integrate the new technology (mandatory setting), and two were not required (voluntary setting). They were also careful to closely replicate natural settings. They searched for four sites that were already about to implement a new system in a span of different industries. Further, they administered surveys pre-, during, and post-implementation. Study 1 examined 48 workers from a manufacturing company who were learning a new system to help with daily tasks that were previously completed manually. The use of the new system was voluntary. Study 2 examined the introduction of an organizational system to 50 employees in a financial firm. Participation in this new system was also voluntary. Study 3 included 51 participants from an accounting firm introducing an account management system that replaced pencil and paper. The system was to override the old method within a one-week span, making the implementation mandatory. In Study 4, 51 bankers were required to implement a new system that was to help them analyze international stock portfolios. Researchers administered the survey containing nine subscales: Intention to Use, Perceived Usefulness, Perceived Ease of Use, Subjective Norm, Voluntariness, Image, Job Relevance, Output Quality, and Result Demonstrability as shown in Figure 2 below on a seven-point Likert scale. 38 usable responses were obtained from Study 1, 39 from Study 2, 43 from Study 3, and 36 from Study 4.

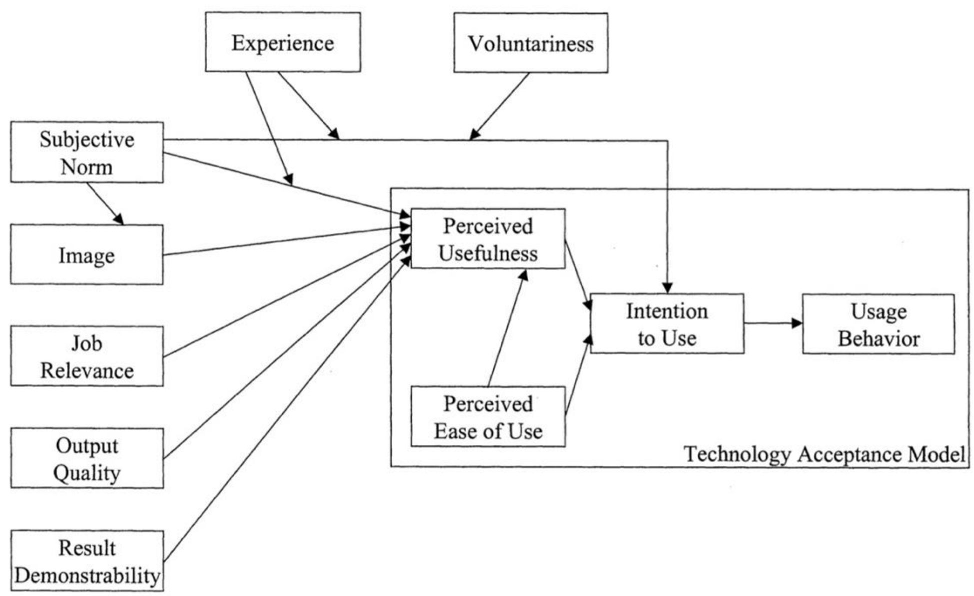


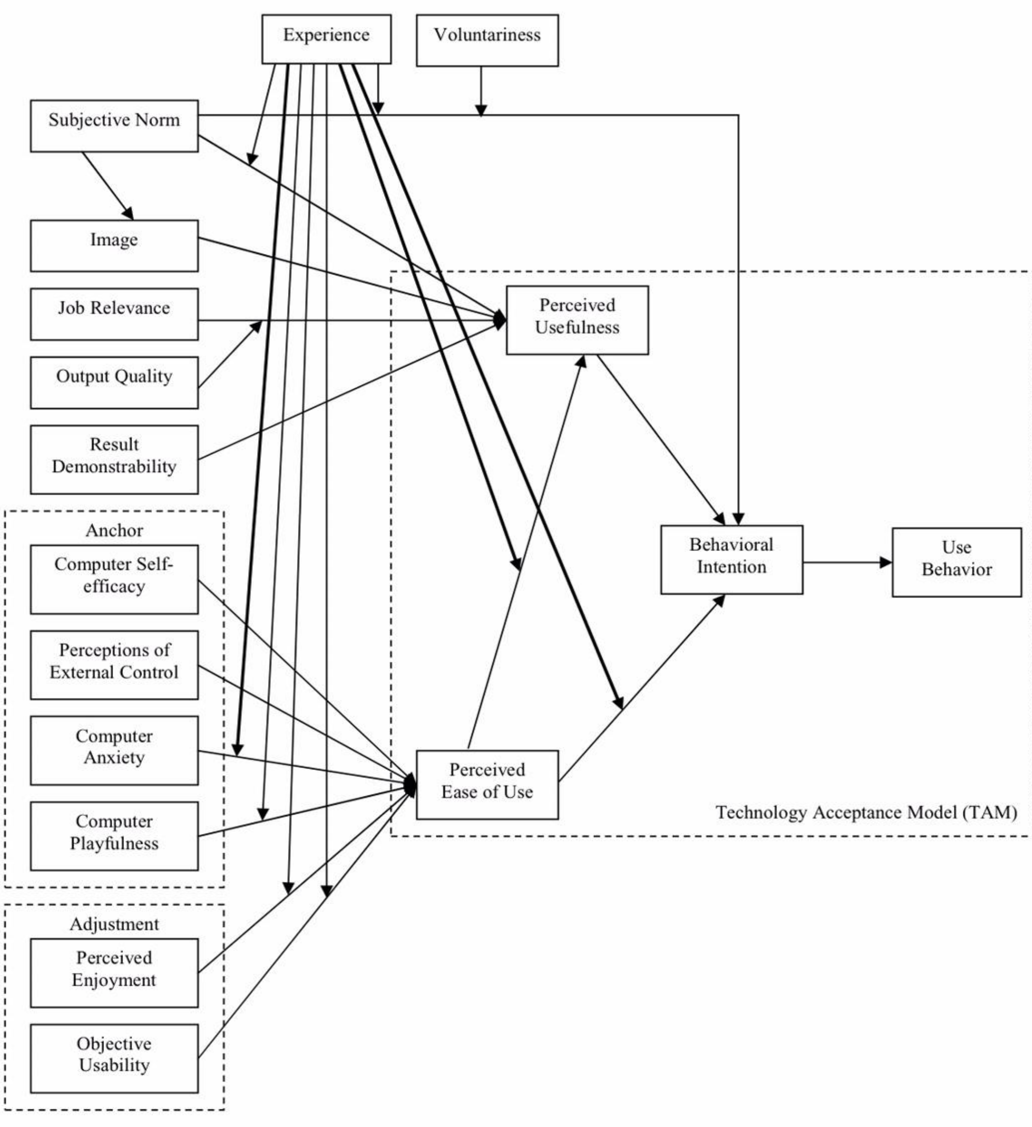
Figure 2. Proposed TAM2 (Venkatesh & Davis, 2000)

Venkatesh and Davis (2000) found high reliability for all the new scales with Cronbach's alpha landing at .80 or higher across studies. Construct validity also proved strong, with cross-loadings all lower than .30. Once the results were pooled across studies and time periods (n = 468), significant correlations were found between subscales. Data were analyzed via regression analysis and found the new subscales to be highly predictive. Subjective norm related to image ($r^2 = .49$, $p < .001$) as well as to intention to use ($r^2 = .44$, $p < .001$). Output quality and job relevance related to perceived usefulness ($r^2 = .40$, $p < .001$) as did result demonstrability ($r^2 = .28$, $p < .001$). All of these factored into perceived usefulness which related to intention to use ($r^2 = .55$, $p < .001$), and intention to use played into usage behavior ($r^2 = .52$, $p < .001$).

This extension of the TAM proved helpful in many ways, including understanding that mandatory approaches provide less desirable attitudes towards the new technology. Venkatesh and Davis (2000) propose use alternatives to mandates by increasing credibility of systems, such as understanding the importance of systems to matching job needs and demonstrating outcomes. This finding falls in line with the underlying psychological assumptions. The addition of the multiple subscales in line with principles of the Theory of Reasoned Action (Fishbein & Ajzen, 1975) address the psychometric properties behind actions in a testable way. By working to understand these aspects, companies, and theoretically implementers across fields, may better understand what is needed for successful implementation. Their new model showed promising results accounting for 40-60% of the variance in usefulness perceptions and 34-52% in usage intentions and all subscales had a Cronbach's alpha of .80 or higher (Venkatesh & Davis, 2000). This study articulates the importance of demonstrating usefulness and credibility of new technological platforms and systems. In school settings, this finding weighs heavily on the use of professional development and administration to create appropriate, reliable supports.

Venkatesh edited this scale once again while working with Bala in 2008, creating the TAM3. Their goal with this extension is to examine the role of interventions in influencing the adoption of technology. The researchers approach this framework establishment and implementation through a psychological research model similar to the previous TAM research but also utilize a vast array of research between the original and this third extension. Venkatesh and Bala (2008) note that while there has been expansive study of the psychological determinants of individual user adoption, there has been little relating to interventions that could increase acceptance. Their research attempts to resolve this gap and propose solutions through a critical empirical review. They examine a large body of work to identify key aspects the TAM could expand on in order to support effective integration.

Through their critical review, Venkatesh and Bala (2008) identify four different categories of determinants for perceived usefulness and perceived ease of use. These are: *individual differences, system characteristics, social influence, and facilitating conditions.* Within each category, key factors are addressed from previous research surrounding communication technology and general intervention properties across subject areas. Next, the determinants of perceived ease of use are: *computer self-efficacy, computer anxiety, computer playfulness, and perceptions of external control (FC).* Venkatesh and Bala (2008) add in six more subscales: Computer Self-Efficacy, Perceptions of External Control, Computer Anxiety, Computer Playfulness, Perceived Enjoyment, and Objective Usability. Figure 3 demonstrates the proposed extension. Computer Self-Efficacy included questions about whether users felt comfortable with learning a new system on their own. Perceptions of External Control revolved around feeling that resources necessary to use the system were available to the user. Computer anxiety was about whether users already experienced stress and frustration with the technological medium already. Computer playfulness was about how comfortable users were with technology. Perceived enjoyment measures whether the use of the system is enjoyable, and objective usability was measured as a ratio of time spent by the participant versus and expert on a set of tasks.



[a]Thick lines indicate new relationships proposed in TAM3.

Figure 3. Proposed TAM3 (Venkatesh & Bala, 2008)

In order to test the updated model, data were collected from four different workplaces already implementing new information technology. Similar to the methods of Venkatesh and Davis (2000), two of the settings had a voluntary adoption of the new system and two were required. Venkatesh and Bala (2008) collected data from these organizations over the span of five months with four different survey administration points**.** The participants in the study were similar to the TAM2 expansion as well. Overall, they found that the new determinants explained between 43% and 52% of the variance in perceived ease of use (Venkatesh & Bala 2008).

Furthermore, Venkatesh works with Davis again to propose the Unified Theory of Acceptance and Use of Technology (UTAUT) in an effort to explain external and internal processes that influence the adoption of new technology and provide managers with a way to determine integration success (Venkatesh et al., 2003). Up until this point, there have been two main veins of research: one relating to individual acceptance and one relating to organizational success. Venkatesh et al. (2003) pull from eight prominent theories to create a unified view and validate the new model. They examine the Theory of Planned Behavior (an extension of the Theory of Reasoned Action); the TAM2; the Motivational Model, which comes from studies about what motivates people to behave in certain ways; the Innovation Diffusion Theory, a sociological theory about how innovations are perceived; and the Social Cognitive Theory about expectations and anxiety. The study cross-examines these theories and the 32 associated constructs to create the UTAUT.

Upon thorough cross-comparison of the eight models, the final UTAUT had eight subscales: Performance Expectancy, Effort Expectancy, Attitude Toward Using

Technology, Social Influence, Facilitating Conditions, Self-Efficacy, Anxiety, and Behavioral Intention to Use the System. Four different organizations implementing new systems were used in this study in the fields of entertainment, telecommunication services, banking, and public administration. Two had voluntary conditions, and two had mandatory conditions. Through a robust, longitudinal study, Venkatesh et al. (2003) tested the UTAUT and found it was able to account for 70% of the variance in intention to use, a much higher percentage than the models on their own. Later expansions of the TAM include the facilitating conditions subscale proposed by this model.

While all of these expansions to the model take place in business settings, the TAM and UTAUT have also crossed over into the field of education around the world (Li et al., 2010; Blackwell et al., 2013, 2014; Wu & Chen, 2016). Many of these studies take variations of the models, such as Blackwell et al. (2013). Blackwell et al. (2013) uses a similar path model to the TAM and UTAUT in their study of pre-school and kindergarten teachers with mobile devices, but they change the categories slightly in an effort to focus on intrinsic barriers to technology integration. As a result, the researchers relay that teaching beliefs, comfort with technology, and the perceived values of technology for the students were the greatest limiting factors to integration.

Recently, Sánchez-Prieto et al. (2016) proposed a modified TAM in their investigation of teachers' attitudes toward mobile technologies in Spain. Sánchez-Prieto et al.'s (2016) model proposes 8 subscales, compiled from previous models: Perceived usefulness (PU), Perceived ease of use (PEU), Behavioral intention (BI), Self-efficacy (SE), Subjective Norm (SN), Mobile device anxiety (MA), and Resistance to change (RC), and Facilitating conditions (FC). They eliminate attitude towards use, due to a lack of significant effect in previous research. The researchers had evaluators look at construct and global validity in their study and took an original 523 constructs down to 26**.** The modified scale has many similarities to both the updated TAM and the UTAUT; however, the questions are specifically tailored to teachers in the education setting. Their proposed expansion is demonstrated in Figure 4 below. A portion of this study focuses on validating their updated model.

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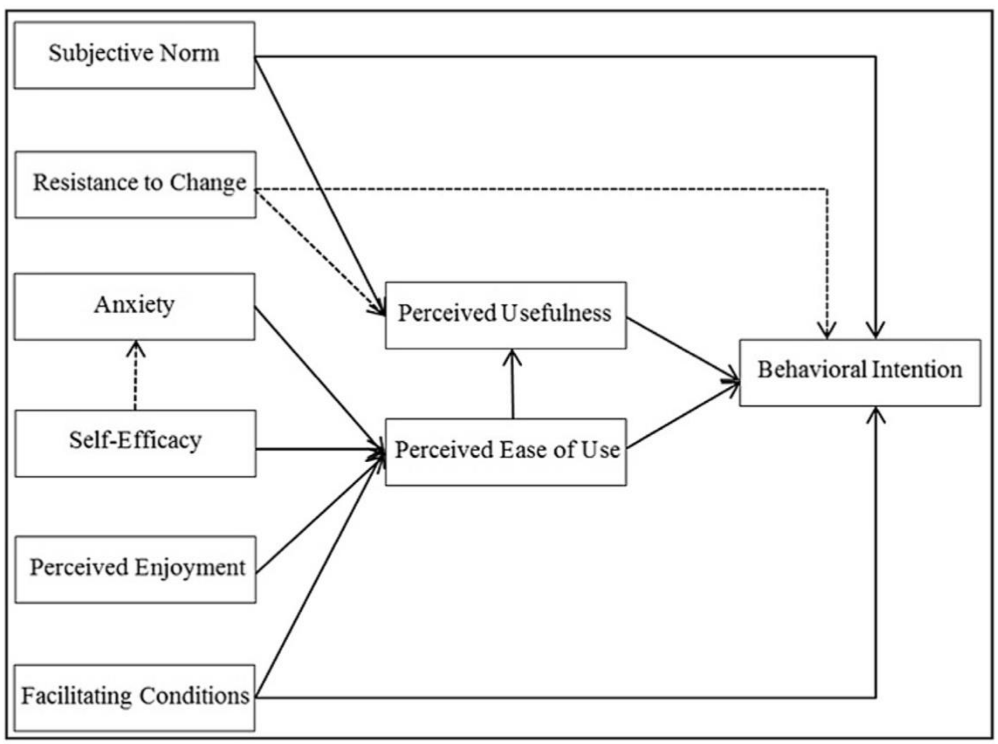


Fig. 4. Extended TAM.

Figure 4. Extended TAM for Education (Sánchez-Prieto et al., 2016)

Technological Acceptance Model Use in Education

Li et al. (2010) utilized the TAM to explore Taiwanese high school students engaging in English language learning courses online. The researchers utilized the original TAM constructs: Perceived Usefulness, Perceived Ease of Ese, and Intention to Use. They further examined external factors that may influence these scales. In order to do this, they created online course design, user-interface design, previous online learning experience, and perceived interaction. Each of these additional subscales were measured on a five-point Likert scale. The participants were students who had exposure to Intelligent Web-based Interactive Language Learning (IWiLL). The platform is sponsored by the Ministry of Education and the National Science Council of Taiwan and reaches over 200 high schools in the country. The survey was administered to high school seniors via the IWiLL website, and the researchers received 436 valid responses: 205 males, and 231 females. Li et al. (2010) found that Online Course Design and User-interface design had significant positive effects on perceived ease of use, and Online Course Design also had a significant positive effect on Perceived Usefulness. Through this study, the researchers found a novel way to apply the TAM not only to education, but also to online course design, helping inform future practices.

Blackwell et al. (2013) utilized a version of the Unified Theory of Acceptance and Use of Technology (UTUAT) in order to research what barriers early childhood educators feel they face when it comes to technological integration. Blackwell (2013) measured social influence and facilitating conditions, subscales in the extended TAM, as well as effort and performance expectancy from the UTAUT. The researchers used the National Association for the Education of Young Children (NAEYC) listserv to administer the online survey. The total participation pool was 1329 educators. Participants came from a variety of programs including center-based care (49% of participants), such as a Montessori school, school-based care (33% of participants), which are associated with the K-12 school system, Head Start centers (11% of participants), and home-based childcare centers (7% of participants). The UTAUT answers were than compared to a survey asking how often per week teachers used different instructional technologies in their classroom. Blackwell et al. (2013) found that home-based programs, programs that had higher student socioeconomic status (SES), and teachers with graduate degrees tended to have more access to mobile technologies as well as utilize them more for instruction.

Blackwell et al. (2014) continued investigating barriers to technological integration in early education. In this study, the researchers focus on systems of support in relation to teacher attitudes. Blackwell et al. (2014) suspected that teachers' perceptions of support as well as school technology policies would influence teacher attitudes towards technology. Participants were again recruited through NAEYC. 1,234 educators participated in this study with 52% from center-based care, 26% from school-based care, and 11% from Head Start centers. The participants were mainly female (98%) and White (87%). The researchers developed an original 46-item survey based on the principles of the TAM and UTAUT in order to measure their questions. Blackwell et al. (2014) found that both perceived support and a positive technology policy in the school did significantly correlated with the teachers' confidence with instructional technology. Both of these Blackwell et al. (2013, 2014) studies show methods for how technological attitudes can be utilized in the field of education as well as what factors may influence teacher perceptions of technology.

Wu and Chen (2016) further the use of the TAM in education research when they looked into Massive Open Online Courses (MOOCs) in China. To conduct their research, they merge the TAM model with the Task Technology Fit (TTF) model. The researchers suggest that the use of the TTF can compensate for missing pieces of the original TAM in relation to external factors such as individual-technology fit and task-technology fit. The participants were members of a MOOCs group in a social networking site called Tencent QQ. The survey returned 252 useable responses: 149 males and 103 females. The majority of the participants (233) were between the ages of 20-30, and most had some form of higher education (238). Wu and Chen (2016) found that the subscales of the TTF did influence the TAM. In particular, individual-technology fit positively influenced perceived ease of use ($p < .001$), and task-technology fit positively influenced perceived usefulness and perceived ease of use ($p < .001$). This extension of the TAM in relation to online learning provides further options relating to design and engagement through technological platforms.

Webinars

From offerings through technology companies to education platforms like Pearson, professional development webinars have become increasingly popular. Apple Teacher also offers some professional development videos and assistance**.** Since KinderTEK2 involves teachers around the United States, webinars offer a comprehensive method for the distribution of information.

Concerning learning effectiveness through webinars, Josi et al. (2012) compared webinar and participatory learning between groups of nurses receiving essential newborn care information in India. The researchers collaborated with the World Health Organization (WHO) and the India Institute of Medical Sciences to create a series of informative sessions about infant care. The two groups mirrored each other in the information, demonstrations, drills, and discussion prompts given. The only difference was that one was webinar (audio-visual) lecture based, and the other was moderator (in-person) learning based. The study showed matching knowledge gain in each group ($p < .001$) suggesting the comparable value of webinar to classroom (in-person) learning.

Lieser et al. (2018) explored developing webinar frameworks in a medical learning environment. They use the Occupational Therapy program at Washington University School of Medicine to explore how to best integrate effective webinar practices. In order to achieve their goals, the researchers created a pilot program beginning with a needs assessment and training to understand what their starting point was. Second, Lieser et al. (2018) collected data about perceptions of existing webinars in the program and used both sets of information to develop an integration tool geared towards active learning. The researchers suggest that in order to effectively integrate webinars, all participants must have preliminary exposure and skills relating to the platform. After allowing participants to practice and train with webinars, the researchers' administered survey included questions about engagement strategies through online education. Once this data was collected, the researchers created a comprehensive framework to fit the needs of the program. The pedagogy behind the framework relies on principles including the importance of matching the technological tool with the necessary tasks; planning with a participatory learning lens; promoting active learning through engagement, exploration, explanation, and extension (4Es Learning Cycle); and identifying best practices with webinars. Lieser et al. (2018) especially take time to note the need to combat online barriers to communication and lecture styles. They acknowledge the importance of using chats, breakout rooms, file sharing, whiteboard, and presenter roles in an effort to mirror the cooperation of participatory learning environments.

The two studies demonstrate the usability of webinars as a learning platform as well as interesting aspects to include in effective webinar creation. These may or may not be considered with KinderTEK since it is a different environment being optional and not directly engagement based. Furthermore, none of these studies address issues relating to technophobia and the possibility that resistance to change may influence a lack of participation in these resources

Research Questions & Hypotheses

The current research is interested in the validity and reliability of the newly proposed TAM (Sánchez-Prieto et al., 2016). The research also investigates the relation between this model and teachers' choices to engage with and integrate a new application in the classroom. It further examines the additional layer of administrative beliefs and their relation to use. The research questions for this study were as follows:

RQ1: Are the constructs in the extended TAM reliable?

Hypothesis 1: Sánchez-Prieto et al. (2016)'s proposed scale will prove to be reliable.

RQ2: Are responses to any of the TAM subscales correlated with participation in the optional professional development offered by KinderTEK?

Hypothesis 2: Positive subscale mean scores will relate to higher participation rates in the optional professional development webinar.

Hypothesis 3: Negative subscale mean scores will relate to lower participation rates in the optional professional development webinar.

RQ3: Are classroom teachers' responses to the TAM correlated to average class usage?

Hypothesis 4: Positive subscale mean scores will relate to higher average student use of application

Hypothesis 5: Negative subscale mean scores will relate to lower average student use of application.

RQ4: Do administrative attitudes relate to their teachers' usage of the app?

Hypothesis 6: Administrator positive subscale mean scores will correlate to higher usage of the app in their subsequent schools.

CHAPTER II

METHODS

Participants

The KinderTEK2 program includes schools across the United States. 40 teachers and administrators are officially registered as a part of this program. The survey was sent out via email to these 40 participants on Thursday, 11/29/2018, and data was pulled in January 2019. Completion of the survey was incentivized by the opportunity to win a $50 Visa gift card. There were 20 responses, but only 19 proved useable, demonstrating a 48% response rate. The remaining participant pool was 57% teachers (11) and 42% administrators (8). This sample was used for the questions of internal consistency of the instrument as well as predictive validity relating to participation in the professional development webinar. Concerning access to usage data, the distribution of administrators and teachers created an issue with within-subject comparisons. This issue was addressed by running true correlations between the teacher responses and usage and providing a descriptive analysis of trends for the nested administrative data through their teachers' usage. The small sample size turned the focus to a descriptive analysis since the data set was too small to be a representative sample.

Instrument

Sánchez-Prieto et al.'s (2015) model consists of 8 subscales, compiled from previous models: *Perceived usefulness (PU), Perceived ease of use (PEU), Behavioral intention (BI), Self-efficacy (SE), Facilitating conditions (FC), Subjective Norm (SN), Mobile device anxiety (MA), and Resistance to change (RC).* Each subscale has three questions in it, except PU and PEU, which have four, creating a total of 26 questions overall. Each item was presented in standard Likert-scale format, with answers ranging from 1, “Strongly Agree,” to 7, “Strongly Disagree.” Perceived usefulness (PU) and perceived ease of use (PEU) were represented in the original model (Davis, 1989). Venkatesh and Davis’ (2000) expansion of the TAM proposed behavioral intentions (BI) and subjective norm (SN) as subscales. Facilitating conditions (FC) was added by Venkatesh et al. (2003), and self-efficacy (SE) and mobile anxiety (MA) came from his work with Bala in 2008 (Venkatesh & Bala, 2008). The last category, resistance to change (RC) was derived from work by Al-Somali, Gholami, & Clegg (2009). Sánchez-Prieto et al. (2015) pull from each of these works to create their extended TAM (Table 1). For this study, the survey instrument proposed by Sánchez-Prieto et al. (2015) was replicated in Qualtrics and distributed via email from KinderTEK administrators.

From offerings through technology companies to education platforms like Pearson, professional development webinars have become increasingly popular. Apple Teacher also offers a plethora of short professional development series and boosters to help teachers use their products. Since KinderTEK2 involves teachers around the United States, webinars offer a comprehensive method for the distribution of information. In order to effectively measure webinar participation, the webinars were embedded into Qualtrics, giving researchers access to view time, engagement, location, and other identifying information.

Data Collection

Data for this study was collected as a convenience sample, since it is specific to the program. KinderTEK2 participants span across the United States, including schools through the Midwest, West Coast, and Hawaii. The extended TAM (see Table 1 below) was administered online via KinderTEK2 emailing list. The email asked KinderTEK2 participants to fill out the attached survey measuring attitudes towards technology. It relayed that if the survey was completed, they would be entered into a raffle for a $50 Visa gift card. At the beginning of the survey, the respondents were offered the option of providing names and were asked about their position in the school. Qualtrics collected the data and recorded identifying information, such as location and email. Since the professional development webinars were embedded in a separate Qualtrics survey, participants could be cross-referenced through recorded identifiers. While engagement levels were recorded in the system in terms of percentage completed, the data were re-coded to create dichotomous responses of 0 (did not engage), and 1 (did engage). A rating of 1 was given for all participants who engaged with over 50% of the webinar.

Usage data were collected through the KinderTEK online dashboard, which automatically recorded the amount of time students used the application as well as reported class averages. The dashboard also records engagement levels, modules completed, and identifies which modes the student used. In this study, the students were only using sequenced mode, where lessons were in predetermined order rather than having free range. Furthermore, in this study only class average use time, categorized by teacher, was used for comparison to the TAM.

All of this data collection was done with University of Oregon Institutional Research Board approval and by CITI or NIH certified researchers. When extracting the preliminary data from Qualtrics, it was downloaded into .csv (Excel) and .sav (SPSS) files on a secured laptop and cleaned for analysis.

Table 1. Items in Extended TAM Sánchez-Prieto et al. (2016)

Perceived Usefulness

1. The use of mobile devices can enhance my job performance
2. The use of mobile devices can make me more effective at work
3. The use of mobile devices in my teaching practice enhances my productivity
4. Generally, I consider mobile devices to be useful in my line of work

Perceived Ease of Use

1. Learning to use mobile devices in the classroom would be easy for me
2. I find it easy to interact with mobile devices
3. Interactions with mobile devices are clear and easy for me to understand
4. Generally, I consider mobile devices easy to use

Behavioral Intention

1. I intend to use mobile devices in the classroom
2. I predict I will use mobile technologies at my job
3. I plan to use mobile devices in the implementation of my teaching practice

Self-efficacy

1. I am able to integrate mobile devices in my teaching practice
2. I can use mobile devices as educational tools even if there is no one to help me
3. I can design materials and activities for mobile devices without external help

Facilitating Conditions

1. I have enough time to include mobile devices in my teaching practice
2. I have easy access to the materials I need to develop educational activities delivered through mobile devices
3. I have the necessary human resources at my disposal to be able to develop educational activities with mobile devices

Subjective Norm

1. My coworkers think I should use mobile technologies in my classroom
2. In my school, teachers are expected to use mobile devices in the classroom
3. The people who influence my behavior think I should use mobile devices in the classroom

Mobile Device Anxiety

1. I have doubt about using mobile technologies in the classroom because I fear making mistakes I cannot correct
2. Generally, the use of mobile devices in the classroom stresses me out
3. I feel apprehension toward the use of mobile devices

Resistance to Change

1. I would like mobile technologies to change the way the teaching practice is implemented
2. I want mobile technologies to change teacher-student interactions
3. I would find it easy to assume changes in the teaching methodology introduced by mobile devices

Results

Analysis 1 – Scale Reliability

Regarding the question of content validity within the extended TAM, a reliability analysis was run through SPSS. The results are displayed in Table 2 below. As shown in Table 2, perceived usefulness (*a* = .87), perceived ease of use (*a* = .95), behavioral intention (*a* = .92), facilitating conditions (*a* = .83), and mobile device anxiety (*a* = .95) all showed high reliability with Cronbach's alpha above .80. Resistance to change (a = .75), subjective norm (*a* = .74), and self-efficacy (*a* = .71) showed lower reliability, however, still remained above the .70 mark.

Table 2. Reliability Coefficients for Each Subscale (N = 19)

	Teachers				Administrators				Total				
Subscale	*M*	*SD*	*Min*	*Max*	*M*	*SD*	*Min*	*Max*	*M*	*SD*	*Min*	*Max*	α
PU	2.11	.595	1.00	3.25	1.96	.509	1.00	2.75	2.06	.553	1.00	3.25	.869
PEU	1.98	.984	1.00	4.50	1.86	.675	1.00	3.00	1.93	.857	1.00	4.50	.948
BI	1.91	.668	1.00	3.33	1.86	.378	1.00	2.00	1.89	.560	1.00	3.33	.920
SE	2.30	.658	1.00	3.67	2.05	.525	1.00	2.67	2.20	.606	1.00	3.67	.706
FC	3.03	1.07	1.33	5.00	2.48	.879	1.00	3.67	2.81	1.01	1.00	5.00	.830
SN	2.64	.875	1.00	3.67	2.33	.839	1.00	3.33	2.52	.850	1.00	3.67	.743
MA	5.24	1.54	2.00	7.00	4.43	1.91	1.00	6.33	4.93	1.69	1.00	7.00	.949
RC	3.52	.861	2.00	5.00	3.10	1.01	1.00	4.00	3.35	.918	1.00	5.00	.752

Note. PU = Perceived usefulness. PEU = Perceived ease of use. BI = Behavioral intention. SE = Self-efficacy. FC = Facilitating conditions. SN = Subjective norm. MA = Mobile anxiety. RC = Resistance to change.

Further, a factor analysis was conducted between subscales to further explore content validity by assesses any possible issues between subscales. Each subscale showed single factor loading within each subscale. A factor analysis could not be conducted as a whole because of the low participation numbers.

In an effort to understand relationships between subscales, a correlational analysis was Some of the most significant correlations included the correlations between PU and BI (r = .527, p = .021) as well as between PU and SE (r = .579, p = .009) and further between PU and SN (r = .651, p = .003) . Significant correlation between SN and PU fall in line with the psychological properties and influences of subjective norms in KinderTEK program. There was a particularly significant correlation between BI and SE (r = .747, $p < .001$). This shows that behavioral intention and perceived self-efficacy with tablets are closely related.

Analysis 2 - Teacher and Administrator Responses in Relation to Professional Development Participation

In regards to professional development webinars offered, the second professional development webinar was only accessed by four participants who took the TAM and 5 KinderTEK2 participants overall. Because of this, no quantitative analysis can be done, but a qualitative exploration was conducted in reference to each participating subject's answers. The four staff that did participate in the optional professional development did not have any identical scores across subscales. However, their scores were somewhat similar in PEU, SE, BI, MA, and RC within a half or whole point of each other. Appendix A shows histograms of TAM scores alongside a table of the PD participants scores.

Analysis 3 – Classroom Usage in Relation to TAM Responses – Direct and nested exploratory analysis.

Correlation analysis was run to explore the relevance of the TAM in relation to usage. The null hypothesis was that positive subscales would highly corelate with usage and negative subscales would correlate with lack of usage. Descriptive statistics showed each subscale to have roughly normal distribution, with a single outlier in perceived ease of use (PEU) and behavioral intention (BI), and two outliers in perceived usefulness (PU). Correlation was applied here because the scatterplot data shows a moderate, positive relationship with a best-fit linear line and a curvilinear line would not fit the data. Upon analysis, no significant correlations were found. The only factor showing promise was resistance to change (r = .337, p = .254). It was speculated that some of this may be due to the small sample size, since only 11 of the 19 participants were teachers and subsequently had any usage data.

Table 3. Teacher Usage and TAM Correlations

Correlations	PU	PEU	BI	SE	FC	SN	MA	RC
Pearson's	.161	-.125	-.050	-.081	-.138	-.163	.146	.377
Significance	.637	.715	.883	.814	.685	.632	.669	.254
n	11	11	11	11	11	11	11	11

Note. PU = Perceived usefulness. PEU = Perceived ease of use. BI = Behavioral intention. SE = Self-efficacy. FC = Facilitating conditions. SN = Subjective norm. MA = Mobile anxiety. RC = Resistance to change.

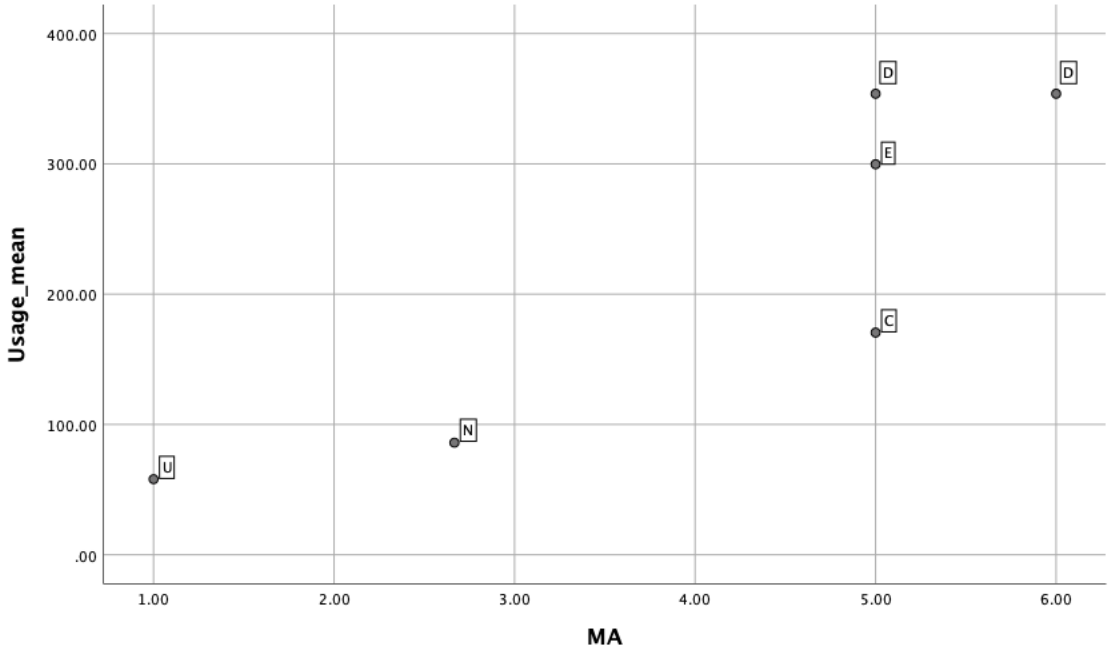
Recognizing that the data received included a number of administrators, creating a nested data set, an aggregate analysis was run in an effort to understand whether administrator attitudes affected teacher usage within the same school system. Teachers and administrators were coded dichotomously 1 for teacher and 2 for administrator. The cases were separated, and a correlation was run.

Because of the split between teachers and administrators, the break variables for the analysis were coded school identifications and the aggregate variable was usage – creating a mean usage per school/administrator. Once data was aggregated, a bivariate Pearson's correlation was run. This analysis did bring forth a significant correlation between Mobile Anxiety and average usage (*r(MA)* = .874, *p* = .023). Though this was the only significant correlations, other interesting correlations were between PU, RC, and SN (*r(PU)* = .707, *p* = .116; *r(RC)* = .528, *p* = .282; *r(SN)* = .592, *p* = .216). Graph 1 shows the response categories with the school labels used to investigate the data.

Table 4. Administrator TAM responses correlated to school usage

	PU	PEU	BI	SE	FC	SN	MA	RC
Pearson's	.707	.084	.597	.290	-.089	.592	.874*	.528
Significance	.116	.874	.211	.578	.867	.216	.023	.282
n	6	6	6	6	6	6	6	6

Note. PU = Perceived usefulness. PEU = Perceived ease of use. BI = Behavioral intention. SE = Self-efficacy. FC = Facilitating conditions. SN = Subjective norm. MA = Mobile anxiety. RC = Resistance to change.



Graph 1. Administrator responses to mobile anxiety versus school usage means. Schools labeled by letter (n = 6).

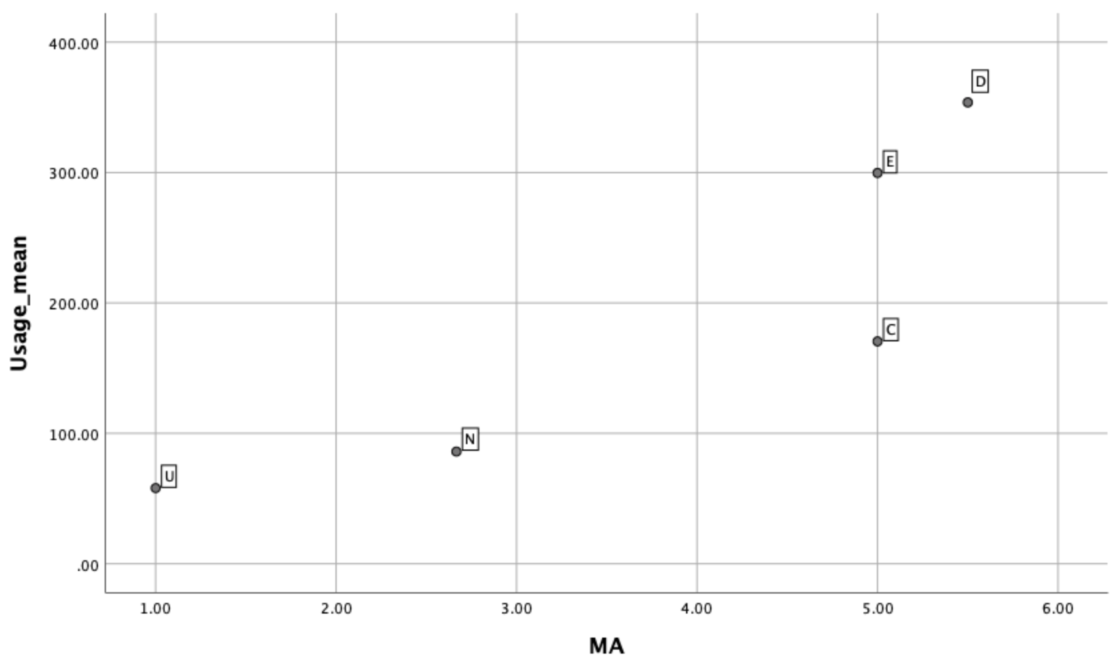
Upon realization of administration density in sample, a scatter plot was examined in order to get a better understanding of the data. The scatter plot analysis showed an error where two of the administrators responding were from the same school. Once this was remedied, it lessened the finding, but it was still almost statistically significant and worth noting, especially with such a small sample size. Table 5 shows the findings with the two administrator responses averaged together.

In order to remedy the administrator stacking, the two administrators from school D were averaged together to create a new point in the data set. The new averaged data correlated administrator mobile anxiety with use at ($r(MA) = .872$, $p = .054$), putting it just out of significance range, but still worth noting. The next closest is PU ($r(MA) = .732$, $p = .159$). Graph 2 shows the data with the new administrator scores by school. It is important to note that the higher the score on the scale, the less mobile anxiety the administrators have. This shows that mobile anxiety is negatively correlated with use, so in other words, the more comfortable they are, the more the teachers in their school used the application.

Table 5. Administrator TAM responses correlated to school usage – School D administrators averaged

	PU	PEU	BI	SE	FC	SN	MA	RC
Pearson's	.732	.286	.584	.290	-.022	.682	.872	.540
Significance	.159	.641	.301	.552	.972	.204	.054	.348
n	5	5	5	5	5	5	5	5

Note. PU = Perceived usefulness. PEU = Perceived ease of use. BI = Behavioral intention. SE = Self-efficacy. FC = Facilitating conditions. SN = Subjective norm. MA = Mobile anxiety. RC = Resistance to change.



Graph 2. *Administrator responses to mobile anxiety versus school usage means. Schools labeled by letter. School D administrator responses averaged (n = 5)*

CHAPTER III

DISCUSSION

This study explored the teacher and administrator attitudes towards technology and how those attitudes affected usage of the KinderTEK math application as well participation in optional professional development. Based on federally funded research, the KinderTEK2 program was specifically created to achieve common core math goals in a sequenced, procedural learning fashion and meet individual students' needs. This application helps the teacher as well as lessens the effects of teacher bias toward students, affording them tailored math plans to advance at their own rate. The TAM has been shown to be able to predict usage in many past studies and has been modified many times. This study validated one of the most recent expansions to the TAM, proposed by Sanchez-Prieto et al. (2016), in which the TAM was tailored towards user adoption of mobile devices in educational settings. The study showed high reliability for the new TAM and proposes usability in the future.

Unfortunately, the data set of teachers and administrators participating in the optional professional development that KinderTEK offers was much too small to gather any substantial data about attitudes towards technology that may correlate to the utilization of optional resources, with only three of the teachers who responded to the TAM survey participating in the professional development. Teacher subscale responses showed no significant correlations to usage. Again, the small sample size limits the power of any statistical test.

However, an intriguing, unintentional finding from this study points to the importance of administrative support. Despite the small sample size, the findings did show interesting results in perceived usefulness and mobile anxiety, with lessened mobile anxiety for administrators being the highest correlation to teacher usage of the application. Even though the result was no longer significant when the administrator responses from school D were averaged together, the strength of these correlations still points to an important aspect of user adoption in the classroom. One possible interpretation of the finding that administrator comfort with technology was strongly related to usage in the school is that comfort enables administrators to support teachers adopting technology in the classroom influences usage.

The findings that perceived usefulness plays an important role but perceived ease of use does not are similar to Hu et al.'s (1999) findings that ease of use showed no significance in adoption, but perceived usefulness did. This could be because as technology becomes more common, people are more willing to work with applications that can help them, despite whether it seems complicated. It could also mean that in school settings, teachers and administrators are willing to work around some of the difficulty that an application or device may present if they believe the outcomes are worth it.

Another interesting way to look at these results is through the eyes of Hedmen and Gimpel's (2010) critique of TAM, "The adoption of hyped technologies: a qualitative study." In their six-month study of iPhone use, the researchers tested out a competitive theory to the TAM, the theory of consumption values. Hedmen and Gimpel's (2010) study argued that social values around technology created more adoption. They found that users were more likely to utilize their iPhones for epistemic, or curiosity-based, and emotional values, such as aesthetic qualities. They found that functional value had little to do with the actual use of the product. This poses another interesting lens through which to view these results. It may suggest that intrigue about a platform could be an overarching factor in user adoption. Administrator’s interest could create a kind of ‘hyped’ environment within a school that could explain how both PU and MA would be the most prominent subscales. In general, the research points to the importance of administrative attitudes to school technology adoption. Future research should explore how administrators can support their teachers to promote use.

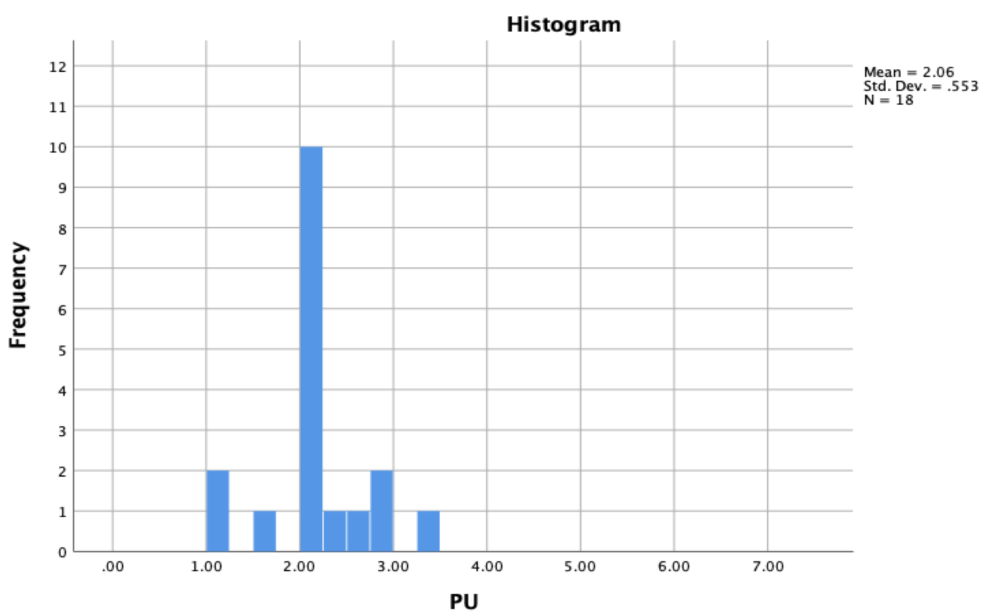
This study faced many constraints including data issues, time constrains, and small sample sizes. With more time and data, more could have been done. Also, multiple options for application usage could have been chosen for analysis. Although mean minutes used seemed like a reliable measure, this research could have used engagement rates or concept mastery for analysis as well as both are recorded in the KinderTEK dashboard. With a longer timeline for analysis, all of these elements could have been examined and warrant further exploration. Furthermore, this study focuses on a subsection of teachers and administrators who likely are either comfortable with mobile devices or eager to try new things based on their desire to participate in this study. Nevertheless, the administrator attitudes aspect of this study should be explored more and poses interesting questions about what may affect use on a building-wide scale, which could be extremely helpful for all schools. Research such as this is important in order to help effectively support teachers integrating technology as suggested by Falloon (2013, 2014). Furthermore, the importance of low mobile anxiety, or comfort with the platform at hand, shows new facets that can help administrators facilitate smooth integration and support their teachers. Supporting teachers is essential to the support of students in the classroom. As a community, we need to be doing all we can to come together and create positive, evidence-based systems of support in order to best improve our education practices as a country and give students the best chance at success.

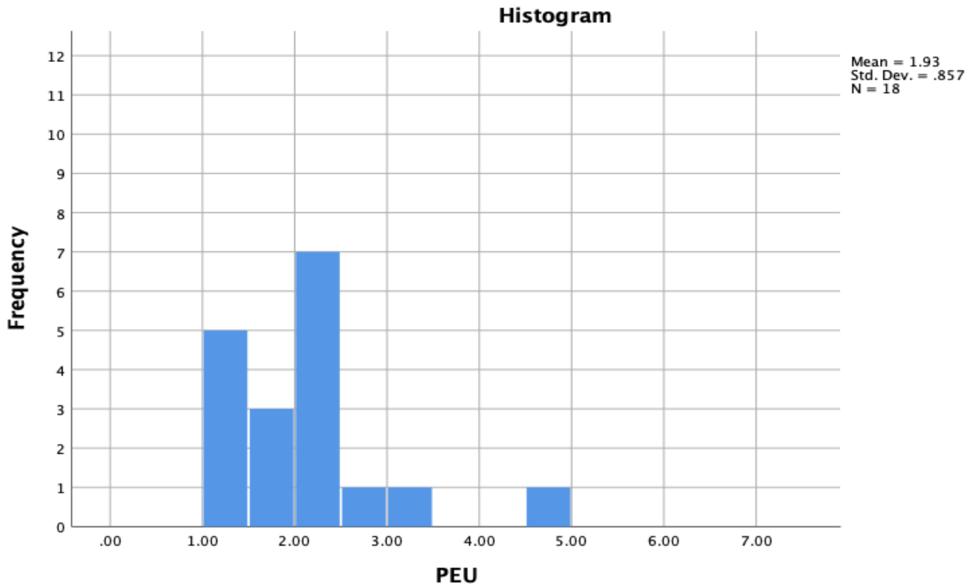
APPENDIX

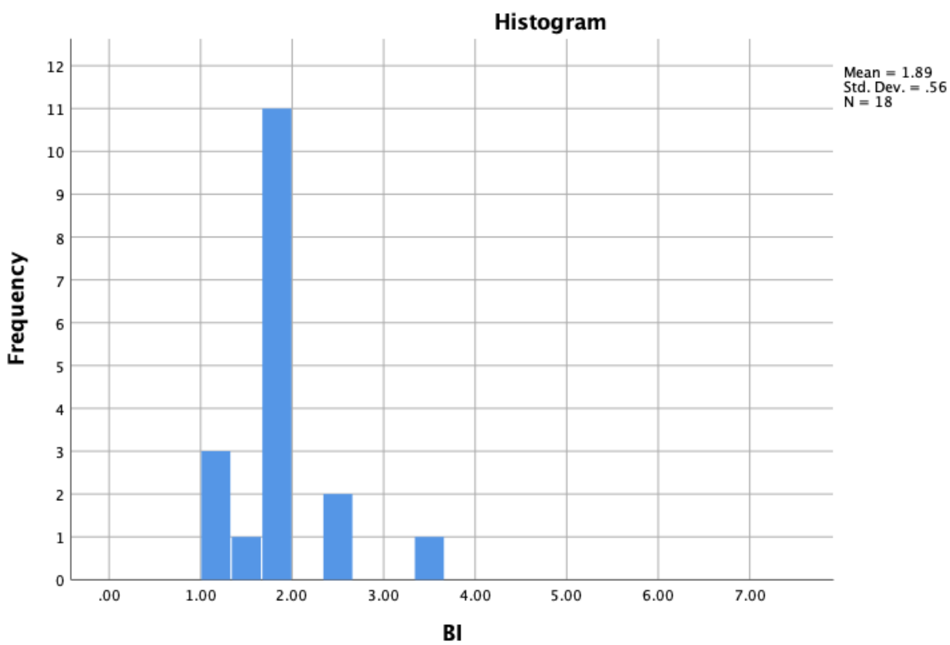
Table 6. PD Participant TAM Scores

Participant	PU	PEU	BI	SE	FC	SN	MA	RC
A	2.25	1.25	1.67	2.33	2.67	3.33	6.33	3
B	2	2	2	2.67	3.33	2	5	4
C	2	2	2	2	2.67	2	6.33	3
D	2	3	2	2.33	2.33	3.33	5	3.33

Note. PU = Perceived usefulness. PEU = Perceived ease of use. BI = Behavioral intention. SE = Self-efficacy. FC = Facilitating conditions. SN = Subjective norm. MA = Mobile anxiety. RC = Resistance to change.




Histogram
Mean = 1.93
Std. Dev. = .857
N = 18
Frequency
PEU
12
11
10
9
8
7
6
5
4
3
2
1
0
.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00


Histogram
Mean = 1.89
Std. Dev. = .56
N = 18
Frequency
BI
12
11
10
9
8
7
6
5
4
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2
1
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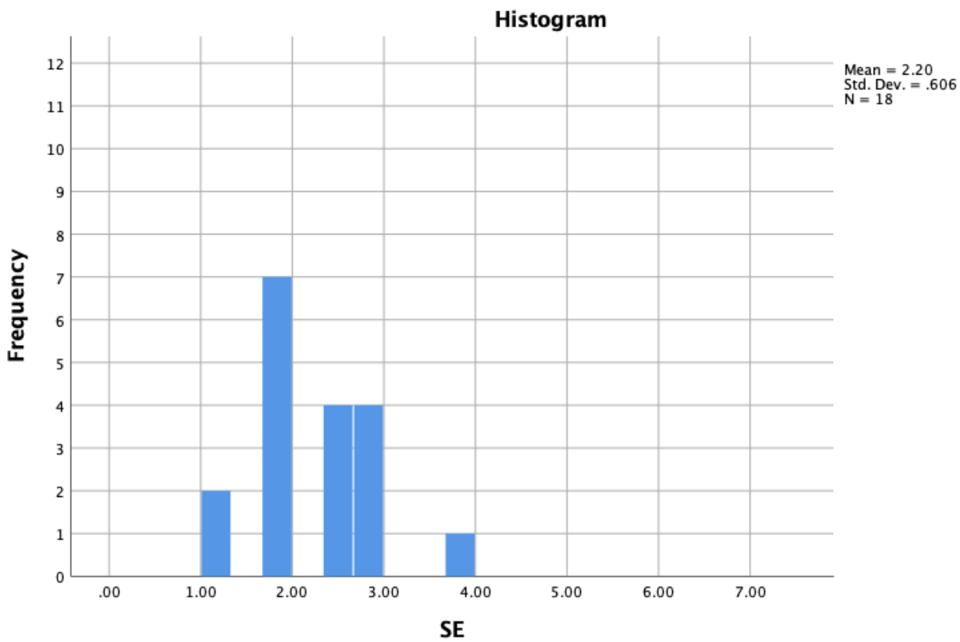
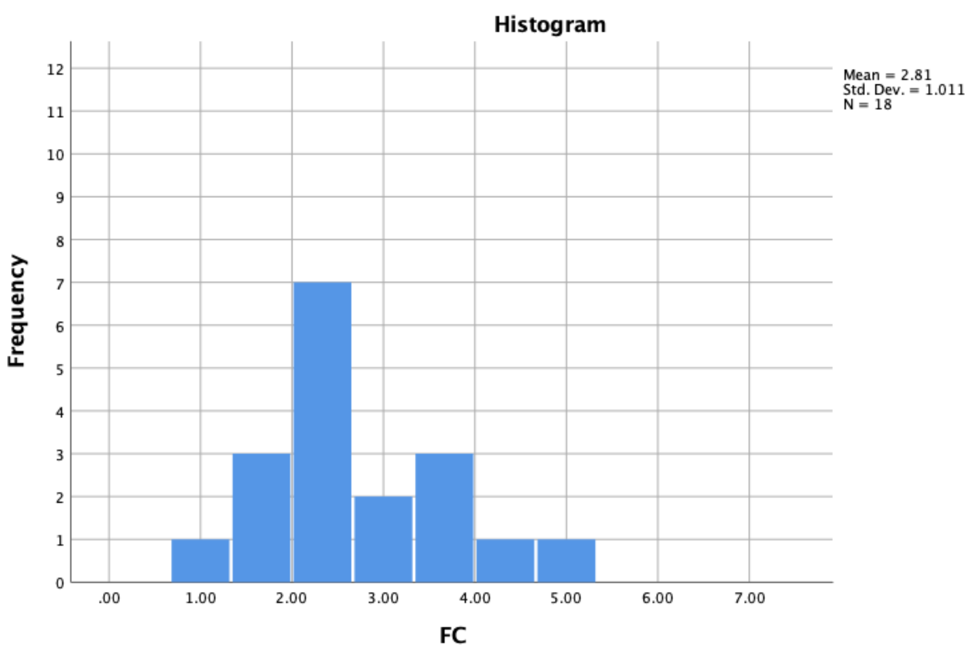
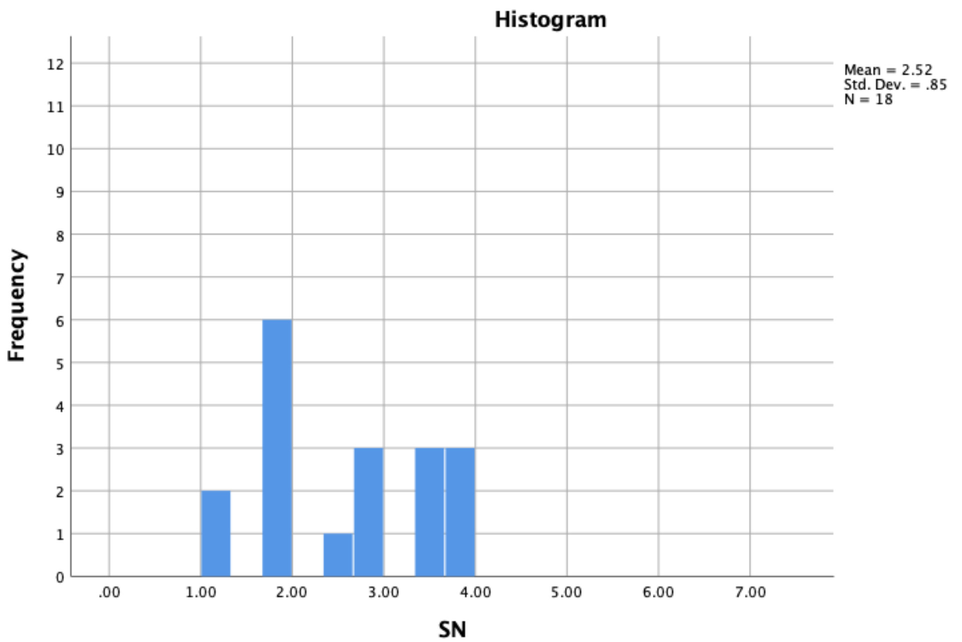
5.00
6.00
7.00


Histogram
Mean = 2.20
Std. Dev. = .606
N = 18
Frequency
SE


Histogram
Mean = 2.81
Std. Dev. = 1.011
N = 18
Frequency
FC


Histogram
Mean = 2.52
Std. Dev. = .85
N = 18
Frequency
0
1
2
3
4
5
6
7
8
9
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11
12
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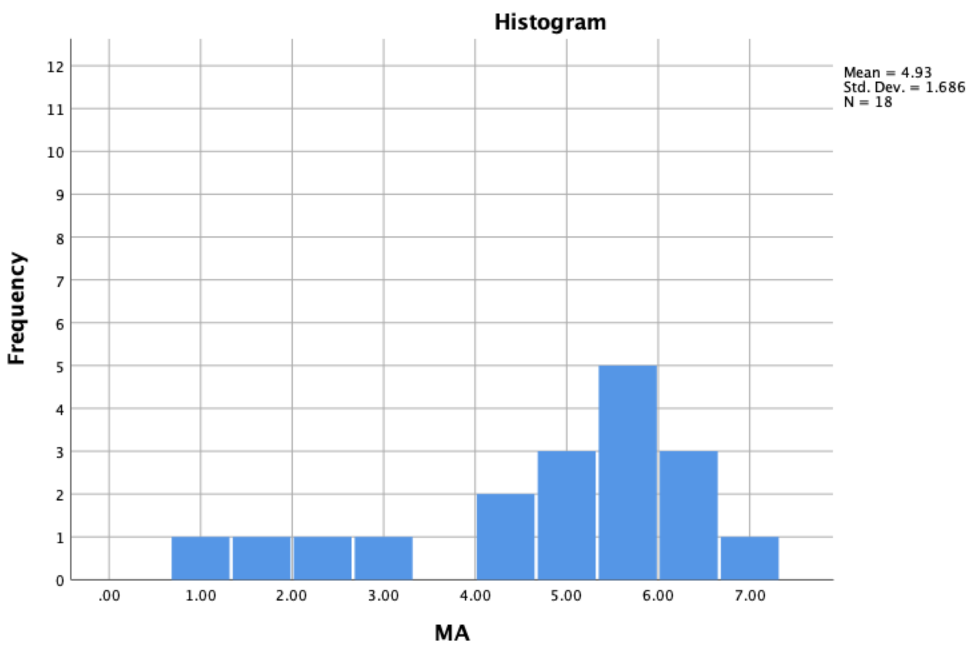
1.00
2.00
3.00
4.00
5.00
6.00
7.00
SN


Histogram
Mean = 4.93
Std. Dev. = 1.686
N = 18
Frequency
0
1
2
3
4
5
6
7
8
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10
11
12
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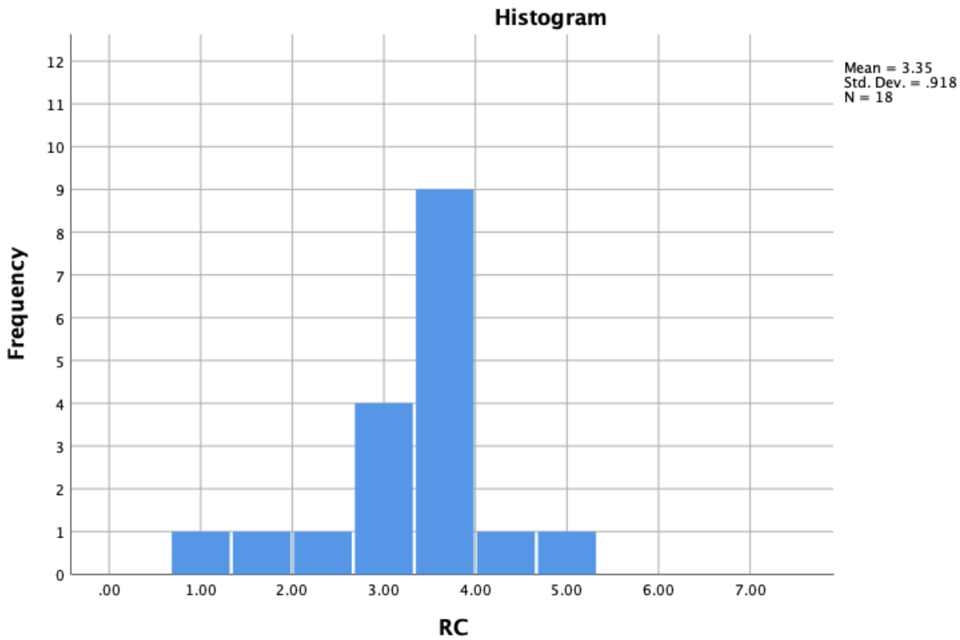
1.00
2.00
3.00
4.00
5.00
6.00
7.00
MA


Histogram
Mean = 3.35
Std. Dev. = .918
N = 18
Frequency
RC
0
1
2
3
4
5
6
7
8
9
10
11
12
.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00

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