EXAMINING THE INFLUENCE OF EDUCATIONAL MOBILE APPLICATION SOFTWARE ON STUDENTS' TECHNOLOGY LITERACY

by

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Dedication

For my heavenly father, father in heaven, Joyce, ToTo, mother, and sisters.

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THANK YOU ALL!

ABSTRACT

EXAMINING THE INFLUENCE OF EDUCATIONAL MOBILE APPLICATION SOFTWARE ON STUDENTS' TECHNOLOGY LITERACY

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The purpose of this mixed methods study was to employ the International Society for Technology in Education (ISTE) Standards for Students as taxonomy to classify educational mobile application (app) software into seven categories and empirically examine the influence on students' technology literacy. A purposeful sample of fifth grade core subject teachers at 19 Title I elementary schools in a large suburban school district in southeast Texas were solicited to provide responses to the online Educational Apps Categories and Usage Survey and to participate in follow-up semi-structured interviews and focus groups. The TechLiteracy Assessment (TLA) was administered to all fifth grade students to assess students' technology literacy in seven strands. A total of sixty-three fifth grade teachers responded to the online survey and sixteen participated in the follow-up semi-structured interviews and focus groups. This study incorporated both quantitative and qualitative data. Quantitative data were collected from the online survey

to determine whether a relationship existed between students' technology literacy in seven strands and categorical choices of educational mobile app software in seven categories. Quantitative data were analyzed using means and Pearson's Product Moment Correlations (r) in IBM SPSS. Qualitative data were collected from follow-up interviews and focus groups. Both were digitally recorded all responses and transcribed verbatim. Qualitative data were analyzed using an inductive coding process in QSR NVivo. Findings indicated higher technology literacy scores in specific technology literacy and were reflective of integrating educational apps in certain categories. There was not a statistically significant relationship between frequency of use of educational mobile app software and school average of TLA scores. Teachers predominately integrated educational mobile app software in the knowledge constructor and the computational thinker categories of the ISTE categories. Findings suggested teachers' perceived a positive influence of integrating educational apps on students' technology literacy. Lack of time, resources, training, and support were among the perceived barriers that impeded the effectiveness of educational apps integration. Limitations, implications, and recommendations for future study research were also discussed in this study.

Keywords: educational mobile app software, ISTE Standards for Students, taxonomy, technology literacy

TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Educational technologies include artifacts, such as a tablet, smartphone, laptop, or mobile application (app) software that could augment and bolster teaching to enhance learning outcomes. Educational technologies have become an integral part of instructional practice in the United States (U.S.) (Hirch-Pasek, et al., 2015; Traxler & Vosloo, 2014). Educational technologies could provide opportunities to improve students' achievement and acquisition of digital literacy skills. Research suggested public schools should value the role of educational technologies in fostering the student-centered learning process and developing technology literacy in the educational context (Kong, Chan, Hunag, & Cheah, 2014). The government has led nationwide implementations of educational technologies at the primary, secondary, and post-secondary levels (Traxler & Vosloo, 2014). Educational technologies continue to permeate education sectors and change the landscape of teaching and learning. There was estimated to be over a million apps available in the app markets in 2015 (Deng, Offutt, Ammann, & Mirzaei, 2017). As educators continue to integrate educational apps into instruction and curriculum in the K-12 settings to increase student achievement, it is crucial for educators and administers to scrutinize the influence of educational mobile app software on students' technology literacy (Hutchison, Beschorner, & Schmidt-Crawford, 2012).

Research Problem

It was estimated that public education spent $4.7 billion on technology integration in K-12 schools in 2015, which includes $1.2 billion in Texas public schools alone (McCandless, 2015; Pittman & Gaines, 2015). Educational mobile app software is an integral part of technology integration. It is defined as a software program developed to run on multiple platforms, such as iPads, tablets, smartphones, laptops, or hand-held gadgets to perform specific functions in the educational context (Cherner, Dix, & Lee, 2014). As the government and school districts continue to spend money on technology integration to improve student's technology literacy, it is crucial to examine how technology literacy could be influenced by the use of educational mobile app software.

To examine its influence, educational mobile app software needs to be classified. Classification can reduce complexity and identify similarities by using taxonomy (Bailey, 1994). There is no known study that employs a standard-based taxonomy to classify educational mobile app software and to empirically examine the influence on students' technology literacy skills (Hutchison, et al., 2012).

Taxonomy can help to identify commonalities or duplicates while providing a simple method to compare, contrast, and understand the complexities and requirements of specific subjects in a given domain (Dombroviak & Ramnath, 2007). An effective taxonomy provides a holistic view and develops a definitive array of application types. However, Nickerson, Varshney, and Muntermann (2013) contended taxonomy development could be challenging and problematic. The authors found that many taxonomies were not based on a conceptual, theoretical, or empirical foundation. There were a few attempts to curate taxonomies to classify educational mobile app software.

Some taxonomies were based on learning theories or pedagogical strategies while others were based on the hardware types, affordances, or features. The following is a summary of taxonomies employed in the extant studies.

Hwang and Wu (2014) reviewed 2,674 articles published between 2008 and 2012, in seven leading Social Science Citation Index (SSCI) journals, and classified educational mobile app software into four contextual categories: language learning, environmental and ecological education, engineering and computer education, and historical and cultural education. The authors concluded that mobile learning could improve students' interests, motivations, and learning achievements. In a similar attempt, Zydney and Warner (2016) conducted a meta-analysis on 34 studies published between 2007 and 2014 and classified educational mobile app software into four broad categories: place-based data collection, games and/or simulations, learning management system (LMS), and productivity tools. The authors suggested future studies to examine the specific features of mobile apps and to develop additional strategies to use mobile apps for collaboration in learning. It was asserted stronger alignment between the classification and assessment of the educational apps was needed.

Cherner, et al. (2014) proposed a classification framework with three categories: skill-based, content-based, or function-based. Notari, Hielscher, and King (2016) attempted to classify the educational mobile app software based on the categories: pedagogical, knowledge and skill building, collaboration, learning and teaching support, communication, and reference. Walker (2011) proposed a taxonomy comprised of six categories: curriculum connections, authenticity, feedback, differentiation, user friendliness, and motivation. These taxonomies were either based on pedagogical goal or

instructional design. Some were too broad to classify the educational mobile app software.

Similarly, Hirsh-Pasek, et al. (2015) proposed taxonomy to evaluate educational mobile app software with four pillars: active learning, engagement, meaningful learning, and social interaction. Kearney, Schuck, Burden, and Aubusson (2012) classified mobile learning app software into three categories: authenticity, collaboration, and personalization. Shroff, Keyes, and Linger (2015) proposed to classify educational mobile app software utilizing learning theories and pedagogical perspectives. Ok, Kim, Kang, and Bryant (2016) evaluated the types of educational mobile app software for learning disabilities in the following categories: drill and practice, game, lecturing or tutoring, simulation, and supplementary tool for learning. Most of these taxonomies were evident-based and not suitable for classifying educational mobile app software.

Hutchison, et al. (2012) contended there was a lack of taxonomy to rigorously classify educational mobile app software. Lee and Cherner (2015) asserted there are several shortfalls in the taxonomies, such as lack of specificity, comprehension, and connection to research. Nickerson, et al. (2013) concluded that classifying objects in a given domain into a taxonomy remains challenging and problematic for many disciplines. Additionally, the authors asserted there was a lack of general taxonomy of educational mobile app software in the educational context. These problems entail a need to curate a framework that embodies a standard-based taxonomy to classify educational mobile app software and to empirically examine the influence on students' learning outcomes. This study employed one well-developed international standard for learning to interweave the taxonomy and the assessment.

The International Society for Technology in Education (ISTE) Standards for Students are widely adopted standards emphasizing the skills that enable students to curate personalization and social aspects of educational technology to promote empowerment, social interaction, and collaboration in learning. In Texas, the State Board of Education (SBOE) adopted the Texas Essential Knowledge and Skills (TEKS) for each common core subject of the state required curriculum (TEA, 2012). The Technology Applications (TA) curriculum for Grade 3-5 has six strands based on the ISTE standards. These standards aim to equip elementary students with essential technology literacy necessary to advance to secondary public schools and beyond. Technology literacy is referred to as skills, such as searching, evaluating, summarizing, analyzing, and presenting information required to solve problems in a digital setting (Jara, et al., 2015). These skills enable learners to search, identify, select, and utilize information needed to develop subject knowledge. Educational mobile app software could provide opportunities to foster technology literacy and means for students to communicate, socialize, and support student-centered and lifelong learning (Hutchison, et al., 2012).

To achieve higher levels of technology literacy, Davies (2011) asserted learners must practice technology in authentic situations. The author proposed a conceptual framework to assess learners' technology literacy. The framework was based on observations from a five-year project that integrated technologies in science classrooms. The taxonomies were adapted from learning objectives with a problem-based learning approach. The author cautioned it could be challenging to measure the extent to which technology was implemented and used. In addition, it would be insufficient to evaluate technology literacy using a use-based model. It was concluded that it is practical to

critically analyze not only why technology is being used but also how well it was used in the educational context.

It has been a priority for many educators to integrate digital technologies into their instructions in order to equip students with new literacy skills in reading, writing, and communicating in digital environments (Hutchison, et al., 2012). Pittman and Gaines (2015) suggested third, fourth, and fifth grade teachers have the potential to shape how students view and use technology as a learning tool. Title I, Part A (Title I) of the Elementary and Secondary Education Act (ESEA), as amended provides financial assistance to local educational agencies (LEAs) and schools with high numbers or high percentages of children from low-income families to help ensure all children meet challenging state academic standards (Department of Education, n.d.). Fifty-nine percent of the U.S. Title I funds were distributed to kindergarten through fifth grade. As fifth grade students at Title I schools exit primary schools, it is imperative to examine their technology literacy as an indicator of readiness before they enter secondary schools. In this study, an ISTE standard-based assessment tool was employed as taxonomy to measure students' technology literacy.

Technology literacy is essential for 21st century workforces. Sessions, Kang, and Womack (2016) concluded that students' technology literacy could be positively improved by integrating educational technologies, such as educational mobile app software, as a supplement to teachers' instruction. However, there is no known study that employs a standard-based framework to classify educational mobile app software and empirically examine the influence on student technology literacy. Additionally, there is

no study that employs a valid assessment to empirically measure students' technology literacy.

Researchers have been trying different assessment methods to measure students' achievement in technology literacy, related to technology integration in the educational context. However, it is common to find that extant studies utilized standardized high stake tests, such as the State of Texas Assessments of Academic Readiness (STAAR) in Texas, to assess students' achievement. Elliot and Mikulas (2012) conducted an in depth assessment pertaining to the effectiveness of technology integration training on student achievement using Stanford Achievement Test Series, Tenth Edition (SAT 10) test.

Kiger, Herro, and Prunty (2012) used central tendency as the assessment to measure and describe test performance and used ordinary least squares multivariate regression analysis to examine the influence of intervention on posttest performance. The authors suggested further studies to examine the influence of mobile learning from personal and social model perspectives were needed. This study sought to examine the influence of educational mobile app software use in classroom on students' social and ethical literacy.

Males, Bate, and Macnish, (2017) also utilized a standardized National Assessment Program Literacy and Numeracy (NAPLAN) test to examine the influence of educational technologies on student's achievement. The authors contended the United Kingdom and the U.S. both have been using high-stake testing to report student achievement since the 1980s. The authors called out for more research on how to link technology integration with student performance. Waters, Kenna, and Bruce (2016) examined the intersection between technology demands and curricular change and

concluded there was no specific standard-based assessment utilized to examine the influence of educational application software. There is a need for an empirical framework, with standard-based assessment, to specifically measure students' technology literacy and to examine the correlation to the educational mobile app software used.

The TechLiteracy Assessment (TLA) is a web-based assessment tool developed by Learning.com. The TLA was developed, based on the ISTE standards, to measure students' technology literacy (TechLiteracy Assessment, 2017). The TLA assessment tool has been administered to over 5 million students, over the past 17 years, to uniquely measure students' technology literacy (TechLiteracy Assessment, 2017). The TLA is designed to assess students' digital literacy skills in seven strands: database, multimedia and presentations, social and ethical, spreadsheets, systems and fundamentals, telecommunication and internet, and word processing. The TLA was validated in 2005 through a field test of over 8,000 students from 68 schools in seven districts (Judson, 2010). This web-based TLA assessment tool has been administered to all 5th grade students at the Southeast Independent School District (SISD) since 2008. All 5th grade students participate in the TLA at the end of the school year to measure technology literacy. The TLA scores for all 5th grade students at 19 Title I schools in the 2016-2017 school year were collected and analyzed to empirically examine the correlation between technology literacy in the seven strands and seven categories of educational mobile app software classified by the ISTE standards.

Educational technologies, such as tablets or mobile app software could provide opportunities for students to acquire digital literacy (Hutchison, et al., 2012). Educational technology is an integrated part of instructional practice in the U.S. (Traxler & Vosloo,

2014). Castek and Beach (2013) investigated affordances provided by educational technologies and concluded that educational mobile app software could provide ample opportunities to foster learner-centered learning and development of 21st century skills. Bester and Brand (2013) found students retain more information with the help of sufficient visual content by using technology. However, Kobelsky, Larosiliere, and Plummer (2014) suggested educational technologies cannot provide an instant fix to boost school performance. As the government and school districts continue to invest in integrating educational technologies into classrooms, it is crucial to scrutinize how students' technology literacy is related to different technologies used in classrooms (Hutchison, et al., 2012). The purpose of this mixed methods study was to employ the ISTE standards as taxonomy to classify educational mobile app software and empirically examine the influence on students' technology literacy.

There are two popular paradigms of technology integration, Electronic learning (E-learning) and Mobile learning (M-learning), in the educational context. E-learning is defined as the use of educational technologies for the purpose of learning (Kong, Chan, Huang & Cheah, 2014). E-learning could provide opportunities to develop 21st century skills in K-12 settings through daily learning activities that use educational technologies for education (Kong, et al., 2014). M-learning is defined as learning through social and content interactions using mobile technologies to engage learners in activities such as creation, collaboration, critical-thinking, and communication (Cobcroft, Towers, Smith, & Bruns, 2006; Crompton, 2013). Fabian, Topping, and Barron (2016) conducted a meta-analysis on 60 published studies. Findings indicated mobile technologies were more commonly used in elementary classrooms in the K-12 setting. The authors found that

more than 50 percent of the studies investigated the influence of educational technologies on student's attitudes and engagement. Additionally, most studies related to technology integration were focused on the device types, such as gaming device and tablet; functional activities, such as interaction and collaboration; learning strategy, such as game-based learning and drill and practice; and duration of intervention. There was no study found in this meta-analysis that examined educational mobile app software and its influence on students' technology literacy. The authors asserted mobile learning is still in its infancy and called for a more rigorous research approach to examining the influence of educational technologies on students' learning outcomes.

Educational mobile app software is an integral part of technology integration. Educational mobile application (app) software directly and closely interacts with learners. It has significantly impacted educational ecosystems through the transformation of formal and non-formal learning (Notari, Hielscher & King, 2016). The affordances and versatilities of educational mobile app software provide prominent opportunities to shift the pedagogy from teacher-centered to student-centered to achieve better learning performance (Looi, et al., 2010).

There was estimated to be over a million apps available in the app markets in 2015 (Deng, et al., 2017). These educational apps were tagged with subcategories consisting of nonstandard-based types and genres, such as games, books, or words. All software in the iTunes store is combined together without a specific organizational pattern (Cherner, et al., 2014). Eighty-six percent of the most popular educational application software listed in the educational category in the iTunes store are not intended to be used in school (Shuler, 2012).

Without appropriate organization and categorization in the app stores, it entails a challenging and difficult process for educators to find the appropriate educational software for their specific needs (Notari, Hielscher, & King, 2016). Consequently, the authors proposed an evidence-based approach to guide the selection and evaluation of educational application software. Park (2011) asserted there is a need for a standard-based rubric to guide software design and to evaluate the effectiveness and appropriateness of educational mobile app software. Lee and Cherner (2015) contended educators need a valid and research-based rubric to assist them in analyzing and evaluating the quality of educational apps.

The dearth of a standard-based rubric for classification and organization could impede the ability for educators to find appropriate educational software in an effective and efficient fashion (Cherner, et al., 2014). Murray and Olcese (2011) concluded that it would be difficult for an average user or K-12 educator, with specific instructional needs, to find relevant educational mobile app software by searching these categories classified in the iTunes store. To address these problems, there is a need for an empirical framework, with standard-based taxonomy as a rubric, to assist educators in identifying, evaluating, and selecting appropriate educational mobile app software. The goal of this study was to employ the ISTE standards to examine the influence of educational mobile app software by interweaving the taxonomy and the assessment to measure students' technology literacy. This empirical framework could evolve as a rubric for educators and school administrators to evaluate and identify appropriate educational mobile app software to improve student's technology literacy.

As educators and administrators embark on integrating educational mobile app software into curriculum and instruction, it is crucial to examine teachers' perceptions and students' attitudes toward the technology interventions. There is little known research pertaining specifically to teachers' perceptions of how educational mobile app software is used in public school classrooms (Domingo & Garganté, 2016). The authors suggested that teachers' perceptions regarding the impact of mobile technology were related to their beliefs of perceived influence on learning processes. Waters, et al. (2016) concluded that educational mobile app software had a very positive impact on teachers' attitudes toward the new technology. The authors also asserted teachers perceived the use of educational mobile app software as a valuable instructional resource to foster engaging and meaningful learning.

About 75% of teachers are recognizing the benefits of integrating technology including motivation and support of various learning styles (Public Broadcasting Service, 2013). Additionally, the results illustrated that 75% of teachers express a high degree of desire for more classroom technology, especially in low-income schools. Johnson, Adams-Becker, Estrada, and Freeman (2015) asserted students could be better engaged in learning by integrating digital tools to foster fluency on producing content such as multimedia and prototypes. Fabian, et al. (2016) concluded that there was a gap in the literature and most of the studies lacked the teacher's voice. The authors called for more studies on teacher's attitudes and perception related to the use of mobile technologies. This study examined teachers' perceptions at 19 Title I elementary schools at SISD.

Studies also suggested educational mobile app software could influence students' attitudes in the learning context. Hilton (2016) examined students' attitudes and asserted

the majority of students demonstrated quite positive attitudes and high levels of engagement in learning mathematics because of affordances within educational apps. Sessions, Kang, and Womack (2016) found that use of educational mobile app software influenced students' attitudes and behaviors, changed the dynamics, and increased the social relations through collaboration with peers. It was concluded that educational mobile app software had affective impact on students' attitudes and behaviors.

Studies found students' attitudes toward the use of educational mobile app software are correlated to learning achievement. Fabian, et al. (2016) concluded in a meta-analysis that student attitudes were mostly positive toward use of commercial off-the-shelf (COTS) educational mobile app software and concluded that attitudes and achievement are interlinked. Males, Bate, and Macnish, (2017) called out for more research to delve into the details on how to link educational technologies and technology integration with student performance. Koehler, Shin, and Mishra (2012) examined teachers' perceptions and concluded that time, lack of resources, training, budget constraints, and inadequate teacher support were the leading factors related to the effectiveness of technology integration. This study examined teachers' perceived challenges and barriers that could impede the effectiveness of integrating educational mobile app software in classrooms.

Castek and Beach (2013) asserted educational mobile app software could support activities such as collaboration, multimodality, and shared productivity that could improve learning achievement. Chiong and Shuler (2010) suggested well-designed educational mobile app software could foster learning. Sessions, Kang, and Womack (2016) concluded that good pedagogy along with appropriate educational mobile app

software could positively influence students' learning. It is crucial to examine teachers' perceptions of the effectiveness and barriers regarding technology integration and how educational mobile app software could influence students' attitudes and technology literacy. In a meta-analysis, Bingimlas (2009) concluded that teachers possessed a strong desire to integrate educational technologies in their classrooms. However, there were several barriers, such as lack of competence, lack of time, lack of confidence, and lack of access to resources, which could hinder the integration of educational mobile app software. In addition, Tallvid (2016) conducted observations of in-service training sessions. The author concluded that barriers that hindered the technology integration could be grouped into five categories: lack of technical competence, not worth the effort, insufficient material, diminishing control, and lack of time. This study examined how teachers perceive the effectiveness and influence of using educational mobile app software on students' technology literacy.

In conclusion, many studies illustrated that educational mobile app software could provide ample opportunities for students to acquire technology literacy. As school districts and educators are spending billions of dollars on implementing E-learning and M-learning to integrate educational mobile app software into K-12 classrooms and curricula, it is imperative to examine the influence of educational mobile app software on students' technology literacy. To rigorously classify and empirically examine the influence of educational mobile app software on students' technology, there is a need to curate a framework that employs a standard-based taxonomy and assessment method. The purpose of this mixed methods study was to employ the ISTE standards as taxonomy

to classify educational mobile app software and empirically examine the influence on students' technology literacy.

Significance of the Study

There is a lack of standard-based framework to rigorously classify and empirically examine the influence of educational mobile app software on students' technology literacy. There was estimated to be over a million apps available in the app markets in 2015 (Deng, et al., 2017). Studies have illustrated that it could be challenging for educators and researchers to evaluate educational mobile app software. This study sought to employ a standard-based taxonomy, based on ISTE standards, to classify educational mobile app software and to empirically examine the influence on students' technology literacy at 19 Title I elementary schools within a large suburban school district in Southeast Texas.

The significance of this study was multi-fold. First, this study addressed the research problem and need to systematically classify educational mobile app software and empirically examine the influence on students' technology literacy related to educational app software used in classrooms. Findings could provide valuable information with regard to the relationship between the categories of educational mobile app software and students' technology literacy. Results of this study indicated a statistically significant relationship between proficiencies in certain technology literacy strands and specific categories of educational mobile app software. The information is valuable for educators, administrators, and policy-makers to gain in depth understanding and make informed decisions on educational mobile app software integration in the educational context. The ultimate goal is to effectively integrate appropriate educational

mobile app software to improve students' learning outcomes and equip them with essential technology literacy.

For example, campuses with lower TLA assessment scores in certain modules could indicate that certain types of educational mobile app software were not properly integrated into instruction. Teachers could consider using more educational app software classified in the categories with higher correlations to those modules with lower scores. In addition, findings illustrate the predominant categories of educational mobile app software used by teachers at 19 Title I elementary schools at SISD.

Second, this study advanced the literature with a standard-based empirical framework by employing widely adopted ISTE Standards for Students to interweave all variables in the taxonomy and assessment tool. These variables include the categories of educational mobile app software and the technology literacy strands assessed by the TLA tool based on one standard. This empirical framework is flexible. The variate to classify educational mobile app software and the variate to assess students' technology literacy could be updated or enhanced to accommodate various software evaluation taxonomies and standards.

Third, findings reveal barriers and challenges that could impede teachers from effectively integrating appropriate apps into classrooms. These barriers could be informative to district administration to make informed decisions regarding technology support, professional development, and content driven training on technology implementation. Additionally, this study examined teachers' perceived effectiveness and influence of integrating educational mobile app software on students' learning outcomes.

Findings provide insights for administrators to make informed decisions on professional development, training, and technology support strategies.

Forth, the empirical framework of this study could be implemented as a rubric for educators and administrators to search, identify, evaluate, and select appropriate educational mobile app software for their instructional needs and integrate software into instruction to enhance learning outcomes and improve student's technology literacy. In addition, online educational app software stores could utilize the rubric evolved from this framework to categorize and organize educational mobile app software. Educational mobile app software developers can utilize this framework as a guideline and incorporate the learning objectives into the software design.

Finally, a myriad of studies suggested that literacy of social interaction and collaboration are crucial for students to succeed in 21st century learning environments. These technology literacies could be improved by integrating educational mobile app software. For examples, Fabian, et al. (2016) conducted a meta-analysis and concluded that mobile technologies could foster functional activities, such as interaction and collaboration, and technology literacies, such as social and interactive skills. In addition, Hsin, Li, and Tasi (2014) synthesized articles that examined the importance of social and collaborative literacy for young learners. The authors concluded that a majority of studies agreed technologies could support and positively influence children's social development to collaboratively achieve a common goal. Findings of this study were significant to support this assertion by proposing an innovative framework to empirically and rigorously examine the influence of integrating educational mobile app software on student's technology literacy.

Research Purpose and Questions

The purpose of this mixed methods study was to employ the ISTE standards as taxonomy to classify educational mobile app software and empirically examine the influence on students' technology literacy. The following research questions guided this study.

1. Are higher TLA scores reflective of the categorical choices of educational mobile app software used in the classrooms at 19 Title I elementary schools?
2. Is there a statistically significant relationship between overall school TLA scores and average frequency of use of educational mobile app software at 19 Title I elementary schools?
3. Are teachers predominately or preferably using educational mobile app software in certain categories?
4. What are teachers' perceptions of the influence of integrating educational mobile app software on students' technology literacy?
5. What are teachers' decision processes, methods, and criteria to search, identify, classify, and select educational mobile app software?

6 What are teachers' perceptions regarding the ease of obtaining and integrating educational mobile app software?

Definitions of Key Terms

21st Century Skills: Skill is defined as the ability to perform tasks and solve problems by using educational technologies conceptualized in three dimensions: information, communication and ethics and social impact. 21st century skills include accessing, evaluating, and organizing information, researching, problem solving, point defining, restructuring, modelling, searching for, selecting, analyzing, socializing, and interpreting information in digital environments (Ananiadou & Claro, 2009). 21st skills are characterized as transversal, multidimensional, and associated with higher order skills and behaviors (Voogt & Roblin, 2012).

Application (App): An item of software that anyone with a suitable platform can install without the need for technical expertise (Martin, Sarro, Jia, Zhang, & Harman, 2016). Software is also referred to as a software application used in mobile devices with an OS. Software are programs developed to run on mobile devices for a specific purpose (Mohapatra, Mohapatra, Chittoria, Friji, & Kumar, 2015).

Common Core State Standards: The Common Core is a set of high-quality academic standards in Mathematics and English language arts/literacy (ELA). It is a voluntary set of educational standards for reading and learning. Forty-two states, the District of Columbia, four territories, and the Department of Defense Education Activity (DoDEA) have adopted the Common Core State Standards. In Texas, the Texas Educational Agency developed the Texas Essential Knowledge and Skill (TEKS) to substitute for the common core standards (Common Core State Standards Initiative, n.d.).

Digital Citizenship: Digital citizenship is defined as “the norms of behavior with regard to technology use” (ISTE, 2016). Digital citizenship is also described as the

characteristics of an individual's behavior, especially within collaborative environments, when engaged with digital tools, such as computers, mobile devices, cell phones and tablets (Searson, Hancock, Soheil, & Shepherd, 2015).

Educational Mobile Application Software: A software program readily downloaded and installed on mobile device to immediately engage and perform a specific function in the educational context (Cherner, et al., 2014; Martin, et al., 2016).

Educational Mobile Application Software Categories and Usage Survey: The researcher of this study constructed this online survey. This survey was validated and revised based on the feedback from a panel of 11 content experts including university professors, director of technologies, and technology specialists (Appendix B). It was administered to a purposeful sample of all fifth grade common core subject teachers at 19 Title I elementary schools to collect the quantitative data for this study.

Educational Technologies. Educational technologies consist of a range of different rapidly converging technologies such as PCs, smartphones, tablets, desktops, laptops, application (app) software, mobile devices, and internet-connection.

International Society for Technology in Education (ISTE) 2016 Standards for Students - The standards for evaluating the skills and knowledge students need to learn effectively and live productively in an increasingly global and digital world (ISTE, 2016).

Texas Academic Performance Reports (TAPR): Prior to the 2012–13 school year, TAPR was known as the Academic Excellence Indicator System (AEIS) reports. TAPR reports combine details of district and campus academic performance with financial reports and information about staff, programs, and demographics. The reports also

provide extensive information on staff, programs, and demographics for each school and district (TEA, 2016).

Technology Integration: A process in which educational technologies are used as tools to support the learning activities. This process involves the establishment of effective ways to incorporate educational technologies such as mobile devices and educational software into the curriculum and instructions as teaching tools" (Keengwe, Pearson, & Smart, 2009).

Technology Literacy: It is defined as the ability to effectively use technologies, such as computers, laptops, mobile devices, software, to accomplish required learning tasks (Davies, 2011). Ananiadou and Claro (2009) referred it as the ability to perform tasks and solve problems in dimensions, such as information, communication, ethics, and social impact. It includes skills such as accessing, evaluating, and organizing information, researching, problem solving, collaborating, socializing, and communicating. Another similar term is digital literacy, which includes the skills to share, collaborate, search, analyze, evaluate, and present (Jara, et al., 2015).

Technology Literacy Assessment (TLA): An online web-based assessment tool developed by Learning.com to measure fifth grade students' technology literacy in: (a) spreadsheets, (b) word processing, (c) database, (d) multimedia and presentations, (e) telecommunication and internet, (f) systems and fundamentals, and (g) social and ethical issues (TechLiteracy Assessment, 2017).

Conclusion

This chapter provides an overview of the research problem, significance of the study, research purpose and questions, and definition of terms related to this study. This study contributed to the existing literature and theoretical frameworks by proposing an innovative framework encompassing the technology-based ISTE standards to rigorously classify educational mobile app software and assess students' technology literacy. Additionally, this study provided empirical evidence on how categorical choices of educational mobile app software influenced students' technology literacy. The next chapter presents a literature review of existing literature and theoretical frameworks that bolster this study.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this mixed methods study was to employ the International Society for Technology in Education (ISTE) standards as taxonomy to classify educational mobile app software and empirically examine the influence on students' technology literacy. Classification is one of the most central and conceptual practices and a foundation for conceptualization, statistics, and data analysis (Bailey, 1994). Taxonomy is an approach of classification that could be employed to classify educational mobile app software and provide a method to compare and understand the complexities and requirements of specific software (Dombroviak & Ramnath, 2007). This study employed the widely adopted ISTE Standards for Students as taxonomy to classify educational mobile app software (ISTE, 2016). The TechLiteracy Assessment (TLA) was used to assess students' technology literacy. The TLA is an ISTE standard-based online assessment tool (TechLiteracy Assessment, 2016). Students' attitudes toward the use of educational mobile app software were correlated to learning achievement (Sessions, Kang, & Womack, 2016). Teachers' perceptions are crucial factors related to the effectiveness of technology integration (Koehler, Shin, & Mishra, 2012). To bolster the theoretical framework of this study, the literature review in this chapter focused on: (a) Classification and Taxonomy for Educational Mobile App Software, (b) International Society for Technology in Education (ISTE) Standards for Students, (c) 21st Century Skills and Technology Literacy, (d) Assessment of Student Achievement, (e) Technology

Integration, and (f) Educational Mobile App Software. This chapter presents a view of current literature, summary of findings, and theoretical framework for this study.

Classification and Taxonomy for Educational Mobile App Software

Bailey (1994) argued that social science research could not be advanced in conceptualization and data analysis without classification. It is the one of most central practices to statistically minimize within-group variance while maximizing between-group variance. Taxonomy is a form of classification. It could provide a structure to organize the knowledge of a field for researchers to study and hypothesize the relationships among concepts (Nickerson, Varshney, & Muntermann, 2013). Taxonomy could help to identify commonalities and redundancies, and provide a simple method to compare, contrast, and understand complexities and requirements of specific software (Dombroviak & Ramnath, 2007). The authors contended researchers and practitioners would need the classification to understand complex domains such as educational mobile app software, however, only a few taxonomies had been proposed in the past.

An effective taxonomy for classification provides researchers with a holistic view and develops a definitive array of application types. Dombroviak and Ramnath (2007) concluded that taxonomy was extremely useful to compare and contrast educational mobile app software. Nickerson, et al. (2013) conducted a meta-analysis on the evaluation of educational mobile app software. The characteristics of educational mobile app software were grouped into the following categories: temporal, communication, transaction, access, multiplicity, location, and identity. It was concluded that classifying objects of a given domain into taxonomy could be challenging and problematic for many disciplines.

In a similar attempt, Hwang and Wu (2014) reviewed the articles published between 2008 and 2012 in seven leading Social Science Citation Index (SSCI) journals. This study found 214 out of a total 2,674 publications were related to the use of educational mobile app software. The authors classified educational apps into four contextual categories: language learning, environmental and ecological education, engineering and computer education, as well as historical and cultural education. It was concluded that mobile learning could improve students' interests, motivations, and learning achievements.

In another attempt to examine published articles on educational mobile app software for science learning from 2007 to 2014, 34 studies were selected that met the inclusion criteria and were classified into four broad categories: place-based data collection, games and/or simulations, learning management system (LMS), and productivity tools (Zydney & Warner, 2016). The authors asserted stronger alignment between the classification and assessment of the educational apps is needed. This study employed the ISTE standards to align the classification of educational mobile app software and assessment of the influence on students' technology literacy.

Shuler (2012) analyzed 196 educational apps and coded them based on the intended age, price, subject/skill-set, school usage, branding, and ratings categories. Murray and Olcese (2011) utilized five categories: developed and adopted, tutor, explore, tool, communicate, and collaborate to examine educational software. The authors asserted educational mobile app software should be developed to foster collaboration and socially negotiate construct knowledge.

Cherner, Dix, and Lee (2014) proposed a classification framework with three categories: skill-based, content-based, or function-based. From the practice theory perspective by mapping everyday mobile practices on to educational activities, Merchant (2012) contended social practice could help in recognizing the role of technology in our daily and school lives. The author argued digital technology and schooling should be rehearsed related to the change in ways of accessing, sharing, and building knowledge in educational institutions. A framework was proposed to guide teacher candidates in selecting, integrating, and effectively using educational mobile app software based on its purpose, content, and value.

Walker (2011) proposed taxonomy comprised of six categories: curriculum connections, authenticity, feedback, differentiation, user friendliness, and motivation. Based on Walker's model, Buckler (2012) proposed a rubric to evaluate six educational apps for learners with special needs in six categories: application, feedback, adjustability, ease of use, cost, and benefits. The author asserted a lack of an evaluation tool and centralized repository for users with special needs. Notari, Hielscher, and King (2016) attempted to classify educational mobile app software based on six categories: pedagogical, knowledge and skill building, collaboration, learning and teaching support, communication, and reference. The authors illustrated perspectives of app categories from learners, teachers, app developers and distributors. It was concluded that it could be difficult to identify and select appropriate educational apps in the app store market.

Using the evidence-based science of learning as a guide, Hirch-Pasek, et al. (2015) proposed a taxonomy to evaluate and select educational mobile app software using four pillars: active learning, engagement, meaningful learning, and social

interaction. The authors asserted only very small portion of apps were designed to promote learning. Lee and Cherner (2015) contended educators need a valid and research-based rubric to assist them in analyzing and evaluating quality of educational apps. The authors synthesized nine previously published frameworks of evaluating educational technologies and grouped them into three domains: instruction, design, and engagement. In addition, the authors grouped educational mobile app software into five sub-domains: rigor, 21st century skills, media integration, cultural sensitivity, and interactivity. However, the authors cautioned that there are several shortfalls in the taxonomies, such as lack of specificity, comprehension, and connection to research.

From the perspective of socio-cultural learning theory, Kearney, Schuck, Burden, and Aubusson (2012) proposed a framework to classify mobile learning app software into three categories: authenticity, collaboration and personalization. The authors asserted learners establish the real world relevance and personal meaning through authentic and collaborative learning. In an attempt to develop a rubric to evaluate educational mobile app software in special education, Weng (2015) conducted a usability test on educational mobile app software by utilizing the categories including purpose, function, data collection, modality, feedback, content, usability, individualization, and tutorial. The author examined nine educational apps and concluded that a rubric was a useful instrument for educators to select appropriate apps.

Shroff, Keyes, and Linger (2015) proposed to classify software from the learning theories and pedagogical perspectives. The taxonomy used in this study included behaviorism, constructivism, social learning, and connectivism. The authors concluded that the methods of using mobile apps and their contents play a crucial role in conveying

messaging to students. Using the scoring and grading system, Ok, Kim, Kang, and Bryant (2016) employed the taxonomy including basic information, content area, objectives, content level, graphics/theme level and types, such as drill and practice, game, lecturing or tutoring, simulation, supplementary tool for learning to evaluate educational apps. The authors asserted it could be challenging for educators to find appropriate apps and they would often make mistakes; using inappropriate apps by randomly selecting apps without examining the educational quality of apps.

In addition, there were few studies that compared educational mobile app software related to design, development, affordances, and user interface such as screen color, size, fonts, customization, and adaptability. Buckler (2012) suggested user interface and adaptability of educational app software were two important quality factors when evaluating the educational apps. It was asserted that educational mobile app software should be examined on how effectively and authentically learning experiences are embedded.

Researchers curated most of these taxonomies. There is no known study that employs a taxonomy based on widely adopted technology standards. This study employed one standard to classify educational mobile app software. In addition, the ISTE standard was employed to empirically assess students' technology literacy.

International Society for Technology in Education (ISTE) Standards for Students

ISTE is a global non-profit organization that promotes the use of technology in education. The ISTE Standards for Students evaluate the skills and knowledge students need to learn effectively and live productively in an increasingly global and digital world (ISTE, 2016). The ISTE Standards for Students emphasize skills that enable students to

engage and thrive in a connected digital world. These standards underpin personalization and social aspects of educational technology to promote empowerment, social interaction, and collaboration in learning. The ISTE Standards for Students include the following seven categories: empowerment, digital citizen, knowledge constructor, innovative designer, computational thinker, creative communicator, and global collaborator as illustrated in Figure 2.1.

The ISTE Standards for Students were employed to rigorously classify educational mobile app software used by 5th grade teachers in classrooms during the 2016-2017 school year. Additionally, an online assessment tool based on the ISTE standards was employed to assess the students' technology literacy. One of the ultimate goals of technology interventions at the Southeast Independent School District (SISD) is to improve students' learning outcomes and equip them with technology literacy for the 21st century workforces. This study examined students' achievement related to educational mobile app software selected and integrated by 5th grade teachers at 19 Title elementary schools at SISD.

Figure 2.1. *The Categories of the ISTE Standards for Students*

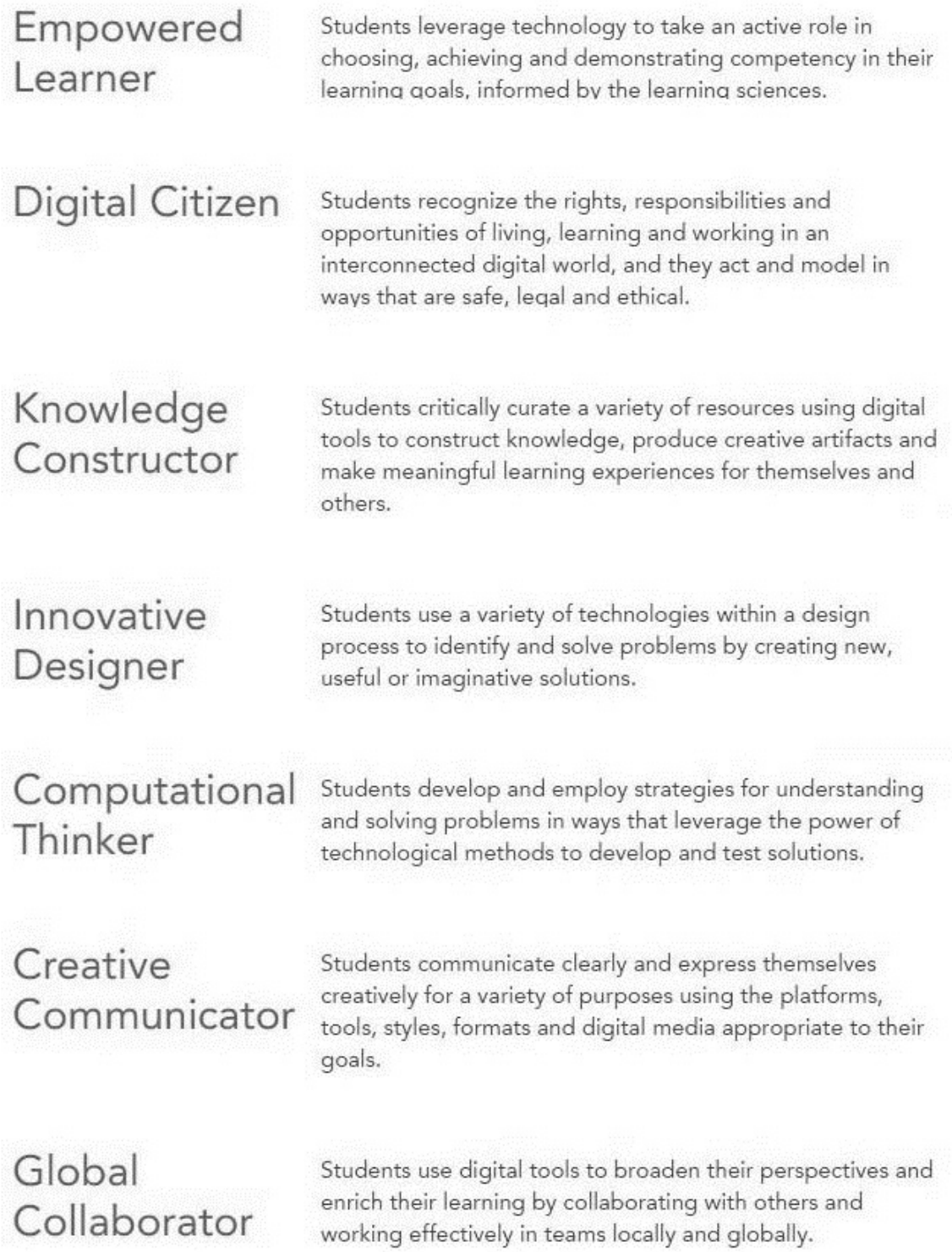

Figure 2.1. The ISTE Standards for Students comprise seven categories. Reprinted from ISTE Standards for Students, in ISTE, 2016. Retrieved July 24, 2017, from https://www.iste.org/standards/standards/for-students. Copyright 2016 by ISTE. Reprinted with permission for educational use.

21st Century Skills and Technology Literacy

Twenty-first century skills refer to the ability to perform tasks and solve problems in dimensions of information, communication, ethics, and social interaction (Ananiadou & Claro, 2009). The authors defined 21st skills that include accessing, evaluating, and organizing information, researching, problem solving, collaborating, socializing, and communicating. Castek and Beach (2013) asserted educational technologies could provide ample opportunities to develop of 21st century skills and foster learner-centered learning.

Voogt and Roblin (2012) examined eight different frameworks from different regions and international organizations related to 21st century skill developments. The authors advocated 21st century skills must become an emphasis in the U.S. due to the rapid development of educational technologies. The authors categorized 21st century skills as transversal, multidimensional, and associated with higher order skills and behaviors. It was concluded these skills are crucial for problem solving and critical thinking in the rapidly changing job markets.

In Texas, the foundation curriculum areas of English language arts and reading, mathematics, science, and social studies require the use of digital technology knowledge and skills in their Texas Essential Knowledge and Skills (TEKS). Based on the TEKS standards, students are expected to master technology applications, such as how to organize, record, and communicate ideas; write, edit, and publish; collect, sort, compare, and organize data; conduct research; create and present multimedia products; use online manipulatives for problem solving, through the use of educational technologies.

According to the 2012-2013 standards, the Technology Applications (TA) performance indicators for Grade 3-5 students include communication and collaboration, digital citizenship, and technology operations and concepts. The TA curriculum ensures students and educators gain and apply critical 21st century digital knowledge and skills across the curriculum. Through these six strands in TA, students foster the technology literacy to use creative thinking and innovative processes, to construct knowledge and develop products, to communicate and reinforce learning, to acquire and evaluate digital contents, to collect, analyze, and report digital information, to practice digital citizenship behaviors, and to learn technology related terms, concepts, and data input strategies. These standards align with the ISTE Standards for Students to evaluate the skills and knowledge needed to learn effectively and live productively in an increasingly global and digital world.

Amended by the *No Child Left Behind Act* (NCLB), Title I, Part A of the *Elementary and Secondary Education Act* (ESEA) is intended to support educational reforms and innovations and to ensure that all children in low-income contexts meet the state's student performance standards (TEA, 2017). Districts are encouraged to offer technology applications in all content areas. This content may also be offered in a specific class while being integrated in all content areas.

Title I schools are campuses with a student population of at least 40 percent identified as low-income (TEA, 2016). Title I is a federal funded grant program providing funds to school districts and schools with high numbers of high percentages of economically disadvantaged students. The purpose of the Title I program is to ensure that all students have a fair, equal opportunity to obtain a high-quality education and reach, at

a minimum, proficiency on challenging state academic achievement standards and assessments. The program contains provisions for ensuring children who are disadvantaged and enrolled in private schools also benefit from the academic enrichment services funded with Title I, Part A funds.

The Title I, Part A, Section 1116 School Improvement program provides supplemental funds to Title I campuses who are identified for school improvement due to failing to make adequate yearly progress (AYP) for two or more consecutive years. Districts distribute these funds to financially support campus improvement plans. The plan for each Title I campus incorporates research-based strategies to improve the performance of participating students in meeting the state's student performance standards.

In Texas, the State Board of Education (SBOE) members nominate educators, parents, business and industry representatives, and employers to serve on TEKS review committees. The SBOE adopted the TEKS for each subject of the required curriculum to measure students' technology literacy (TEA, 2012). The State Educational Technology Directors Association (SETDA) defined technology literacy as the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information to improve learning in all subject areas and to acquire lifelong knowledge (State Educational Technology Directors Association, 2007).

The purpose of NETS-S is to set the standards for technology applications using creative thinking and innovative processes to construct knowledge and develop products. For Grades 3 to 5 in Texas public schools, technology literacy is specified in Chapter 126. Texas Essential Knowledge and Skills (TEKS) for Technology Applications (TA)

Subchapter A. Elementary, 19 TAC Chapter 126: TA for Grades 3-5 students is specified under TEKS §126.7 (TEA, 2012). The TEKS TA curriculum was developed to ensure students and educators gain and apply critical 21st century digital knowledge and skills across the curriculum.

Kong et. al. (2014) asserted learner-centered instruction could support and develop 21st century skills through core subject knowledge learning by integrating educational technologies into classrooms. The popularity of educational technologies drives the use of technologies and increases the literacy of the communication and collaboration skills to complete learning activities and achieve learning outcomes. The authors contended it would be the prominent goal of school education over the next 10 years to foster student's 21st century skills by integrating the educational technologies into the classrooms.

Technology literacy or digital literacy also refer to various skills, such as searching, evaluating, summarizing, analyzing, and presenting information required to solve problems in a digital setting (Jara, et al., 2015). Digital literacy enables learners to search, identify, select, and utilize information to develop subject knowledge. The authors suggested that social, cultural, and economic factors would affect digital literacy based on those without an equal access to the technologies. It has been a priority for many literacy teachers to integrate digital technologies into their instructions to equip students with new literacy skills in reading, writing, and communicating in digital environments (Hutchison, Beschorner, & Schmidt-Crawford, 2012). The 5th grade students' technology literacy could serve as an important indicator for the schools and

district to evaluate the effectiveness and efficiency of their government funded Title I school-wide programs.

In Texas, students' technology literacy is mandated by the Texas Education Agency (TEA) in the Texas Essential Knowledge and Skills (TEKS) for Technology Applications (TA), Texas Education Code, §7.102(c)(4) §28.002 and the TA curriculum are based on the NETS-S and performance indicators developed by the ISTE standards (TEA, 2012). Judson (2008) found technology literacy gains could lead to heightened subject specific confidence in the K-12 setting. Davies (2011) asserted that it is imperative to critically examine how integrating educational technologies into instruction could influence technology literacy.

Assessment of Students' Achievement

To empirically examine students' technology literacy, assessment tools should be associated with the NETS-S standard. There were some studies that investigated and analyzed the influence of educational mobile app software. However, these studies investigate in areas, such as engagement, perceptions, self-efficacy, and motivation using standardized common core subject test scores. The following are some extant studies that examined the influence of educational mobile app software on students' learning outcomes.

When analyzing the effect of technology on learner attention and achievement in the classroom, Bester and Brand (2013) found students retain more information with the help of sufficient visual content by using technology. The experimental and the control groups consist of 23 and 22 fifth graders respectively. Data were collected through the self-completion questionnaire survey, achievement, and attention test. This study found

significant differences between the average achievement learners and between the average attention learners. A highly positive relationship was found between motivation and concentration. Meanwhile, moderate to high positive correlations were observed between attention, concentration, and motivation. Findings indicated higher levels of learning goals and comprehension scores could be achieved by integrating educational apps to provide contents and learning materials.

Kobelsky, Larosiliere, and Plummer (2014) examined the effects of changes in Information Technology (IT) on performance in the not-for-profit sector from an informational and transforming approach. In this large-scale study, archival common core test data including 6,300 schools and 700,000 students in third, eighth, and eleventh grades were examined. Findings from this study provided a starting point for estimating the extent and the timeline of performance impacts that could be expected from changes in how IT is used across a large number of schools.

In an effort to conduct an in depth assessment to investigate the effectiveness of technology integration training on student achievement, Elliot and Mikulas (2012) administered the pretest and posttest on reading comprehension and mathematics Stanford Achievement Test and Tenth Edition (SAT 10) to 629 students in a treatment group and approximately 240 students in a control group at schools in three states. The data were collected to examine the growth in reading and mathematics skills by comparing their pretest scores at the beginning of the study to their posttest scores at the end of the study. An Analysis of Covariance (ANCOVA) was conducted to examine the same data by gender and ethnicity. According to the results, students showed greater learning in classes where teachers used higher level of technology integration. Findings

indicated substantial influence on students' learning in reading and math could be related to teachers with higher levels training and technology integration.

To investigate the frequency of use of educational mobile app software in classrooms, Domingo and Garganté (2016) administered a 5-point Likert scale form to 102 teachers at 12 public schools about the use of educational apps of 2,550 pupils. The authors employed taxonomy comprised of three categories: learning skills tools, informational management tool, and content learning tool. Findings suggested that a large amount of educational software was frequently used in public school classrooms. In addition, a higher frequency of educational apps use had a higher impact on students' achievement through contents and skills learning. In addition, results illustrated teachers integrated more educational apps in the content learning category (three apps), informational management category (two apps), and the learning skill category (one app). This study examined if higher frequency of use of educational mobile app software could attribute to higher students' technology literacy and to determine predominant and dominant categories of educational mobile app software integrated in classrooms.

Kiger, Herro, and Prunty (2012) examined the influence of a nine-week mobile learning intervention on third grade mathematics achievement. This study included 41 students in the treatment group and 40 students in the control group. In addition, four teachers, who shared similar teaching experiences and teaching styles, participated in this study. This study used central tendency as the assessment to measure and describe test performance and used an ordinary least squares multivariate regression analysis to estimate the treatment influence on posttest performance. Findings indicated a statistically significant performance advantage on medium-sized and on the most difficult

multiplication items as well using their self-constructed 100-item post-intervention multiplication test (64 single-digit items, 36 double-digit items). This study examined the influence of using technologies, such as iPods, internet, and interactive whiteboards. The authors suggested examining the influence of mobile learning from a multidimensional view including a personal and social model. This study examined the influence on students' social and ethical literacy related to the use of educational mobile app software in classrooms.

Males, Bate, and Macnish, (2017) concluded a standardized test, National Assessment Program – Literacy and Numeracy (NAPLAN) in Australia, was used to examine the influence of educational technologies on students' achievement in reading, writing, language conventions, and numeracy. It was contended the standardized high stake tests in reading, writing, and numeracy ignored the key digital literacy skills, such as communication, problem solving, and synthesizing online information. The authors asserted the results of using standardized testing to evaluate the students' learning is limited and called for more rigorous and accurate measures on students' technology literacy skills. The authors called out for more research to delve into the details on how to link educational technologies and technology integration with student performance. Additionally, there is no known study that investigates the influence of the educational mobile app software on students' technology literacy.

TechLiteracy Assessment (TLA)

The ISTE Standards for Students emphasize the literacy related to technology. This study employed an ISTE standard based assessment tool, TechLiteracy Assessment (TLA), to measure students' technology literacy. The TLA is a web-based assessment tool aligned with the ISTE NETS-S standard to measure students' technology literacy developed by Learning.com (TechLiteracy Assessment, 2017). The validity of the TLA assessment was established by a field test of over 8,000 students from 68 schools in seven districts in 2005 (Judson, 2010). The TLA has been administered to over 5 million students in the past 17 years (TechLiteracy Assessment, 2017). The TLA is designed to assess students' digital literacy skills in seven strands: database, multimedia and presentations, social and ethical, spreadsheets, systems and fundamentals, telecommunication and internet, and word processing.

There is no known study that examines the influence of educational mobile app software on students' 21st century skills. To rigorously classify and empirically examine the influence of educational mobile app software on student's technology literacy, taxonomy and an assessment method should be based on a standard that is congruent with 21st century skills and technology literacy. The goal of this study was to curate an empirical framework that employs one standard, the ISTE Standards for Students, to interweave the taxonomy, TEKS TA curriculum and instruction, and assessment as illustrated in Figure 2.2.

Figure 2.2. *Proposed Innovative Framework*

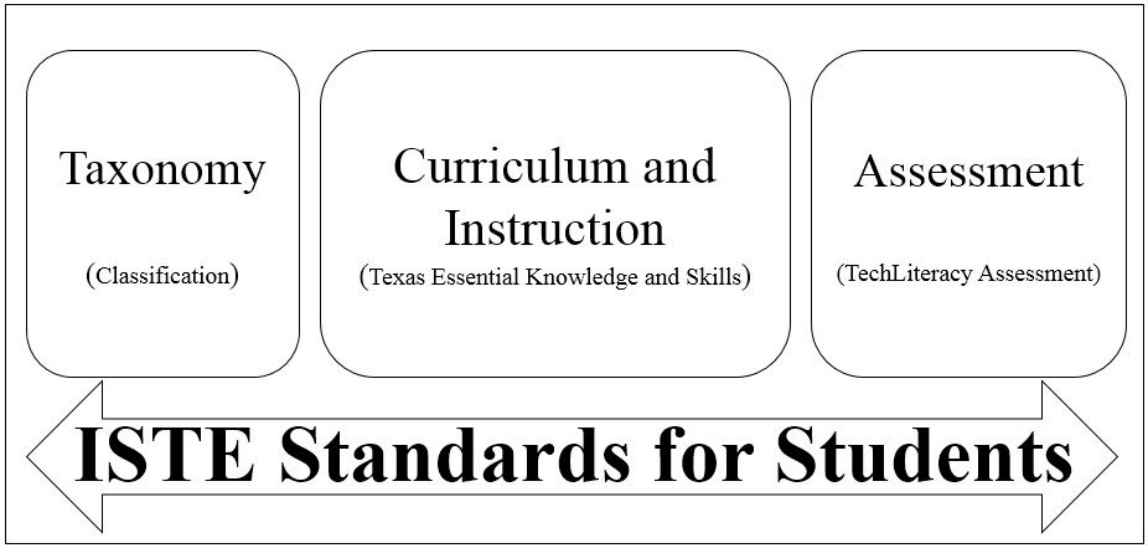

Figure 2.2. This study proposed an innovative framework that employs the ISTE Standards for Students to interweave three components, taxonomy, curriculum and instruction, and assessment, and employ this framework to classify educational mobile app software and empirically examine the influence on students' technology literacy.

Technology Integration

Attributed to the recent skyrocketed sales of tablet devices and the government led nationwide implementation of educational technologies, educational technologies have become an integral part of instructional practice in the U.S. (Traxler & Vosloo, 2014). Educational technologies such as iPads, smartphones, tablets, Chromebooks, laptops, and mobile apps have changed the landscape of learning and provided opportunities for students to acquire digital literacy (Hutchison, et al., 2012). Session, Kang, and Womack (2016) concluded students' technology literacy could be positively improved by integrating educational technologies such as educational mobile app software as supplementary to teachers' instruction. In addition, the authors asserted educational apps made learning more social and engaging. Social and ethics literacy is

one of the constructs to be examined in this study pertaining to the use of educational mobile app software.

According to national web-based interviews in 2013, PK-12 teachers were integrating digital learning more than ever in their classrooms. Approximately 48% of teachers reported using technology for online lesson plans and web-based educational games or activities (Public Broadcasting Service, 2013). Roughly 75 percent of the teachers recognized the benefits of integrating technology, including motivation and support of various learning styles. In the same report, results illustrated that 74 percent of participants indicated educational technologies motivated students to learn and it enabled the reinforcement and expansion on content. More importantly, findings suggested that 75 percent of teachers expressed a high degree of desire for more classroom technology, especially in low-income schools.

The K-12 students of today were born and grew up with a wide array of technologies integrated into their daily lives (An & Reigeluth, 2011). Based on the learner-centered characteristics, the authors organized educational apps into personalized and customized learning, social and emotional support, self-regulation, collaborative and authentic learning experiences, and assessment for learning groups. It was asserted there is an increased emphasis on learner-centered pedagogy to engage these digital natives in K-12 classrooms.

Jones, Scanlon, and Clough (2013) asserted mobile technologies could provide learning benefits in both informal and semiformal contexts. The way students consume content and knowledge at schools across the globe has shifted from passive to direct production. In the 2015 New Media Consortium (NMC) Horizon Report, Johnson,

Adams-Becker, Estrada, and Freeman (2015) asserted students could be better engaged in learning by integrating digital tools to foster fluency on producing contents such as multimedia and prototypes.

Recognizing the need to integrate new technologies, President Obama's ConnectED initiative called for an effort to train teachers to support personalized and flexible learning (The White House, 2013). The goal of the initiative is to empower teachers and to prepare students using the best technologies and rich digital contents. Mouza (2008) asserted educational technologies could enhance how children learn by supporting four fundamental characteristics of learning: (a) active engagement, (b) participation in groups, (c) frequent interaction and feedback, and (d) connections to real world contexts when students used technologies as a learning tool.

Computer technologies could be used to enhance students' inquiry-based learning. Technology could facilitate resource utilization and support cognitive and metacognitive processes. Wang, Kinzie, McGuire, and Pan (2010) concluded educational technologies allow for both the teacher and the student to take part in the instructional process and could be an effective learning tool when utilized properly by teachers during instruction. The ultimate goal of technology integration is to improve students' achievement and technology literacy in the educational context. The following section provides a summary of two popular paradigms of technology integration.

Electronic Learning (E-learning) and Mobile Learning (M-learning)

E-learning is defined as the use of educational technology for the purpose of learning (Kong, Chan, Huang & Cheah, 2014). It is also referred to as a system that aggregates educational technologies to unite learning and technology (Aparicio, Bacao, &

Oliveira, 2016). Stein, Shephard, and Harris (2011) employed a phenomenological research method to investigate tertiary teachers' and teaching support staff conceptions of E-learning. The authors concluded E-learning could enhance learning through the integration of educational technologies to support teaching and communication.

E-learning could provide opportunities to develop 21st century skills through daily learning activities by using educational technologies in K-12 settings (Kong, et al., 2014). The authors examined several educational policies pertaining to E-learning in the Asia–Pacific countries. Findings suggested education sectors should value the role of educational technologies to foster the student-centered learning processes and to develop 21st century skills in the educational context. The authors asserted there is an increasing emphasis on student's capacity building in E-learning environment. It was concluded that the goal of E-learning policies for the next 10 years should be geared to student-centered learning and development of the 21st century skills to proficiently and ethically use educational technologies for daily learning.

M-learning is defined as learning through social and content interactions using mobile technologies to engage learners in activities, such as creation, collaboration, critical-thinking, and communication (Cobcroft, Towers, Smith, & Bruns, 2006; Crompton, 2013). Park (2011) defined M-learning as "the use of mobile or wireless devices for the purpose of learning while on the move" (p. 79). These wireless devices include smartphones, palmtops, and other handheld devices.

In a meta-analysis on M-Learning literature, Wu, et al. (2012) defined M-learning as learners engaged in educational activities; using technology as a mediating tool for learning via mobile devices accessing data and communicating with others through

wireless technology. Crompton, Burke, Gregory, and Gräbe (2016) attempted to explore and synthesize empirical evidence on the use of M-learning for science education. M-Learning is referred to as the processes of coming to know through conversations across multiple contexts among people and personal interactive technologies.

Kearney, et al. (2012) asserted M-learning could support three features: authenticity, collaboration, and personalization. Findings indicated learners establish real world relevance and personal meaning through authentic learning. Walker (2011) defined authenticity as the extent to which learners connect learning experiences with their prior knowledge, through engagement in genuine learning problems.

Kearney, Burden, and Rai (2015) administered an open-ended survey to examine the relationship between the use of pedagogical features of M-learning and the constructs of collaboration, personalization, and authenticity. Authenticity was referred to as the use of educational technology in a similar way to how the tool would be used by practitioners in the real world. Participants in this study were observed using the camera on the phone to record the process of dissecting organs and kept the photos as study notes. Findings indicated participants positively perceived the influences of M-learning, with a higher rating on authenticity, while the ratings on online collaboration and social networking were surprisingly lower. In addition, results illustrated participants preferred to use educational technologies in the collaboration construct for conversation and data sharing. These two components are related to the social and telecommunication strands measured by TLA.

Park (2011) synthesized M-learning literature and contended the recent innovations of Web 2.0, including the software and applications such as blogs, Twitter,

and YouTube, have increased the potential of mobile devices in education. According to the author, M-learning could be summarized as an extension of E-learning that affords just-in-time and transformative innovations for learning. M-learning could provide unique pedagogical affordances and technological attributes such as a broad range of applications, portability, computing power, diverse communications, and synchronization among devices that transform individual learning to collaborative and socialized learning.

Both E-learning and M-learning paradigms integrate and utilize educational technologies, such as mobile devices and mobile app software, into classrooms and engage learners through social and content interaction. Educational mobile app software is an interface that closely and directly interacts with learners. It could provide ample opportunities and affordances to foster learning. It is an imperative to scrutinize the influence of educational mobile app software on students' learning outcomes and technology literacy.

Educational Mobile App Software

Educational mobile app software is an integral part of educational technologies. It refers to software programs developed specifically for mobile devices, such as desktops, smartphones, wearables, and tablets that could be readily downloaded from app stores or app markets to be installed on compatible mobile devices and used to immediately engage and perform a specific function in the educational context (Cherner, et al., 2014; Martin, Sarro, Jia, Zhang, & Harman, 2016). The educational mobile app software market is rapidly growing. There was estimated to be over a million apps available in the app markets in 2015 (Deng, Offutt, Ammann, & Mirzaei, 2017). Educational apps could support education in an array of functions such as games, productivity, health, and social

networking (Bouck, Satsangi, & Flanagan, 2016). Hutchison, Beschorner, and Schmidt-Crawford (2012) found students learned to digitally communicate and creatively collaborate by integrating educational mobile app software, such as the Doodle Buddy and Popplet. Findings indicated students collaborated in small group to produce the visual representation of stories using graphics. This study examined the multimedia and presentation literacy related to use educational apps in categories, such as creative communicator and global collaborator.

Hirch-Pasek, et al. (2015) asserted educational mobile app software could foster social and interactive learning and information could be transmitted between individuals. Chiong and Shuler (2010) concluded well-designed educational mobile app software could foster learning to gain literacy. Sessions, Kang, and Womack (2016) asserted appropriate educational application software, as supplementary to teachers' instructions, could positively influence students' learning, particularly in the ability to create motion visualization objects.

There were an estimated 30,000 applications that were categorized as "education" for iPhones, iPods, and iPads as of June 2010 (Murray & Olcese, 2011). In January 2015, there were approximately 80,000 educational mobile app software in the Apple's iTunes store (Hirch-Pasek, et al., 2015). All software in the iTunes store is combined together without a specific organizational pattern (Cherner, et al., 2014). Eighty-six percent of the most popular educational application software listed in the educational category in the iTunes store were not intended to be used in school (Shuler, 2012). There is a need for a rigorous and standard-based framework to assist educators and administrators on evaluating and selectin appropriate educational mobile app software.

Billions of dollars have been spent in integrating technological tools, such as hardware and software, into classrooms (Pittman, & Gaines, 2015). The authors asserted teachers' attitudes pertaining to the use of technology played a crucial role in technology integration. This study also examined how students' technology literacy could be related to the use of educational mobile app software from teachers' perspectives.

Elementary Teacher Perceptions of Educational Mobile App Software

Very little research examines how teachers perceive the effectiveness of using mobile app software in the educational context. To explore teachers' perceptions on the use of educational apps, Domingo and Garganté (2016) administered a survey to collect data from 102 teachers from 12 different primary schools in Spain. Findings suggested teachers perceived a positive impact of educational mobile app software use on learning and an improvement of students' engagement. Additionally, it was asserted teachers who used certain educational mobile app software, such as the learning skills software in the classrooms, perceived a significantly higher level of learning impact than the teachers who have not used similar apps. Three categories, learning skills, informational management, content learning, were used in this study. The authors concluded that the limited number of categories was a limitation and called for more rigorous research on new categories. This study employed categories, such as the empowered learner, the knowledge constructor, and the computational thinker, to examine the influence of using educational mobile app software on students' technology literacy.

In an attempt to understand how teachers perceived the impedance related to technology integration in K-12 science classrooms, Hechter and Vermette (2013) examined the barriers and implications related to technology integration for K-12 in-

service science educators. A 10-item online survey was administered to a group of 433 science educators. Data was collected and analyzed using the Technology, Pedagogy, and Content Knowledge (TPACK) as the assessment framework (Koehler, Shin, & Mishra, 2012). The descriptive statistics indicated teachers' perceptions of leading barriers were inadequate. Among all the barriers examined in this study, access, time, lack of resources, training, budget constraints, and inadequate teacher support were the leading factors related to technology integration. An and Reigeluth (2011) concluded that more than half of the participants in their study perceived lack of time and technology were prominent barriers of creating technology-enhanced and learner-centered classrooms. Additionally, Kervin, Verenikina, Jones, and Beath (2013) investigated personal, social, professional, and organizational factors related to technology use in literacy teaching from the Activity Theory perspective. Data were collected from a sample of 213 primary school teachers by using a survey with 27 items. Findings indicated that 99% of participants spent time after school on integrating technology to support teaching. Eight-seven percent of teachers spent more than one hour, 27% spent two or more hours each day, and some even reported spending more than 30 hours a week outside school hours doing administrative work.

Waters, Kenna, and Bruce (2016) attempted to specifically examine how educational mobile app software supported the Common Core State Standards instruction. They selected five educational mobile app software and used them in the training sessions. The focus was on the educational mobile app software connects to the instruction using a detailed description of the educational mobile app software in the history and social studies classrooms. Findings indicated that teachers recognize the value

of integrating educational mobile app software into their instruction to meet subject standards. It was also concluded that the use of educational mobile app software had a very positive impact on teachers' attitudes toward the new technology. Additionally, the authors asserted teachers discerned use of educational mobile app software as a valuable instructional resource to foster engaging and meaningful learning.

In a mixed methods study, Vu, McIntyre, and Cepero (2014) investigated teachers' attitudes related to how hardware and educational mobile app software were used in classrooms. The ISTE Classroom Observation Tools (ICOT) instrument and a classroom observation form were administered to collect data from 21 elementary and secondary teachers in three different school districts. Findings indicated teachers had positive attitudes toward using educational mobile app software on iPad's. It was suggested there were a lot of excellent educational apps in the app market. The authors concluded that it is worth of trying to integrate educational apps into the teaching practice. However, studies cautioned technology integration should not be implemented using a "top-down" approach (Kucirkova, 2014). Software and professional development are crucial to the success of technology interventions.

A body of literature showed educational mobile app software could affect students' attitudes and consequently influence students' learning outcomes. The following section summarized the correlation between the use of educational mobile app software, students' attitudes, and learning achievement related to the use of app software.

Elementary Students' Attitudes towards Educational Mobile App Software

Dündar and Akçayır (2014) investigated the attitudes, expectations, and views of high school students toward the use of technology. Two hundred and six students from

four high schools participated in this mixed study. Findings indicated students developed positive attitudes if they perceived a technology as easy to use and useful. Hilton (2016) employed a mixed method to measure students' attitudes toward the use of educational mobile app software. Participants were second to sixth grade students at an urban public school with mixed gender and socio-economic backgrounds. The author employed a survey, with 5-point Likert-type items, to measure students' attitudes pertaining to educational mobile app software use in learning mathematics. Findings indicated that the majority of students demonstrated quite positive attitudes and high levels of engagement in learning mathematics related to the affordances of the educational app, such as the interactive touch screen and ease of use. It was concluded there is a strong influence pertaining to students' and teachers' attitude because of "novelty, challenge, and variety within apps" (p. 12).

The author stated that students were enthusiastic about the variety and choice offered by the educational app software compared to paper-printed books. As the author suggested, using software in classrooms could positively influence students' engagement. For example, the author suggested using educational mobile app software, to provide students with both choices and opportunities, could increase the levels of engagement. Teachers also reflected that the multiple levels offered within software could engage a diverse range of students including ones with special needs. As one of the participants stated:

> I really like the Mathletics app and Targeting Maths—they're really good to help you learn because with both of them you can do a variety of maths things. Targeting Maths lets you do numbers, shapes and patterns, money, data and you

> can also do it timed…I think everyone in our class really likes being in the iPad class because it's different instead of just learning—there are lots of tasks and variety. (James, Year 6 student, 2014 – 2015 cohort). (p. 14)

The author concluded that using the educational mobile app software has a positive influence on students' mathematical self-perceptions. One of the findings supports the variable "Multimedia and Presentations" in one of the participants stated:

> We have an app called Explain Everything and you can put everything there—you can put photos, record your voice—it's like a slideshow thing so you can explain and record your voice while you're moving things on the screen to explain your thinking. I do think I learn more. There's an app called Khan Academy and it's like this maths academy that posts videos about each topic in maths and you can look at them and then put what you learned into your own presentation to explain it yourself—to represent it in your own way. (Brad, Year 6 student, 2014 – 2015 cohort). (p. 14)

Findings suggested using educational software in classrooms could lead to better achievement in technology literacy. This study examined if a relationship exists between the use of educational mobile apps software and students' technology literacy.

In an attempt to investigate the effects of integrating educational mobile app software on students' attitude, Sessions, et al. (2016) assigned a group of 5th grade class students into two tracks with a heterogeneous mix of both gender and academic abilities. Students in the treatment group received instructions with writing software. Findings indicated educational mobile app software influenced students' attitudes and behaviors. It was asserted that use of educational mobile app software changed the dynamics and

increased social relations and collaboration. Additionally, the authors concluded that findings of a positive social attitude impact were congruent with other studies. It was suggested educational mobile app software could improve student's confidence by motivating students to actively engage in learning.

Fabian, Topping, and Barron (2016) conducted a meta-analysis on 60 published papers related to the effects of using commercial off-the-shelf (COTS) educational mobile app software available from apps markets on students' attitudes. The authors asserted that students' attitudes and achievement were interlinked. Findings indicated student attitudes were mostly positive toward the use of COTS. Additionally, results suggested collaborative and interactive activities were among the most used functions by elementary school students. These two learning outcomes are related to the social and intercommunication variable to be measured using the TLA.

When examining the impact of the use of technology in mathematics lessons on student achievement and attitudes, Eyyam, Ramadan, and Hüseyin (2014) investigated student attitudes towards technology use in class and whether the use of technology improved their academic achievement. One-way ANCOVA analysis and principal component analysis (PCA) were used in this study to examine how the progress scores of the students were distributed on data collected from three groups as experimental groups (N = 41) and two as control groups (N = 41). In this study, the researchers administered a survey with open-ended questions. The data was analyzed using the *Educational Technology Perception Scale* (ETPS) to investigate student attitudes towards technology use. The authors suggested mathematics post-test results of the students, who were instructed using technology, were significantly higher than the controlled group. Results

showed students had a positive attitude towards technology use and half of the students preferred the use of educational technology in class.

Software Use and Students' Achievement

In an attempt to examine educational mobile app software in note taking, annotation, and screen casting categories, Castek and Beach (2013) asserted students could communicate ideas by exploiting app affordances. It was suggested educational mobile app software could support activities, such as collaboration, multimodality, and shared productivity. In addition, the authors concluded educational mobile app software could improve the learning achievement, such as identifying visual features, sharing ideas with one another, and producing reports. For example, students could communicate ideas or create digital products that include visual representations. These learning outcomes are related to the telecommunication and multimedia presentations variables to be examined in this study.

Castek and Beach (2013) suggested apps could support literacy learning if educators integrated and used them in innovative ways. The authors stated that sharing and collecting evidences and thoughts collaboratively is an important disciplinary literacy in science learning. Educational mobile app software could provide the affordance that could foster students' collaboration by working together to accomplish the same task. In addition, findings indicated students could add drawings to images and transfer to the use of multimedia. Sharing tasks involves social interactivity and communication, which is related to the social and ethical literacy. Visual processing is related to the multimedia and presentation literacy. Both literacies were measured, by the TLA in this study to

examine the relationship related to the use of educational mobile app software in classrooms.

Studies has illustrated that technology literacy could be developed in young children as early as zero to eight years old (Hsin, Li, & Tasi, 2014). In this meta-analysis study, the authors reviewed published articles related to technology integration between 2008 and 2013. Findings suggested young children were able to use multimodal cues, such as pictures, sounds, and gestures, and search information online using the Google search engine or YouTube. The authors urged administrators to rethink the roles of technology in young children's development.

Hirch-Pasek, et al. (2015) found educational mobile app software use could foster socially interactive learning. It was asserted information transmitted between individuals, through the use of educational mobile app software that is designed with Science of Learning as a foundation, could act as "natural pedagogy". This outcome is related to the social and ethical literacy to be measured in this study. Chiong and Shuler (2010) attempted to examine how educational technologies influence young children and advance their learning. The results indicated well-designed educational mobile app software could foster learning and promote literacy skills by using software such as Martha Speaks and Super Why. The authors cautioned research design and industry to carefully target pressing educational needs tied to literacy.

In a study to integrate writing mobile app software for 5th grade students, Sessions, et al. (2016) found stories produced by the treatment group students moved forward in dynamic ways and the products were much more like movies. The authors asserted good pedagogy, along with appropriate educational mobile app software as

supplementary to teachers' instruction, could positively influence students' learning particularly in the ability to create motion visualization objects. It was concluded students using educational mobile app software had stronger visualization and precise sequencing in their story. The visualization and sequencing skills are both related to the multimedia literacy, which were measured in this study.

Educational mobile app software could provide opportunities to foster learning and improve literacy. It plays a crucial role in technology integration. As government and public schools continue to invest in E-learning and M-learning, it is imperative to empirically examine students' technology literacy related to the categories of educational used in the K-12 setting.

Summary of Findings

To examine the influence of using software on student's technology literacy, educational mobile app software needs to be classified. Classification could reduce complexity to identify similarities and differences. Taxonomy could help to identify commonalities and redundancies, and provide a simple method to compare, contrast, and understand the complexities and requirements of specific software. Much of the extant research focused on classifying or evaluating software in their design, development, affordances, user interface such as screen color, size, fonts, customization and adaptability, curriculum, learning experiences, or authentic learning.

There are few studies related to the development of taxonomies for educational objectives. Some of these taxonomies were based on learning theories, such as behaviorism or constructivism, while some utilized cognitive process dimensions, such as analyzing or evaluation. A few taxonomies were based on teacher-centered learning or

learner-centered learning. The researchers curated most of the taxonomies. There is a lack of a standard-based taxonomy to rigorously classify educational mobile app software.

The ISTE Standards for Students are widely adopted to guide curricula and instruction. The ISTE standards emphasize the technology literacy that enables students to engage and thrive in a connected digital world. Technology literacy is essential for students to embrace the 21st century workplaces. Few studies advocated that development of students' technology literacy must become an emphasis in the United States. In Texas, the TEKS and TA standards for public schools were developed to align with the ISTE standards. Educational mobile app software is being integrated in classrooms to achieve instructional goals. This study employed the ISTE standards as taxonomy to classify educational mobile app software.

There were few studies that utilized standardized high-stake tests to assess students' learning achievement, related to the use of educational mobile app software. A few studies utilized evidence-based observation as a measurement to assess students' engagement, motivation, and enjoyment. There is a need to employ a standard-based assessment tool to empirically assess students' technology literacy in the educational context. The TLA is a valid web-based assessment tool developed from the ISTE standards to assess students' technology literacy in seven modules: database, multimedia and presentations, social and ethical, spreadsheets, systems and fundamentals, telecommunication and internet, and word processing.

Educational technologies include mobile devices, such as tablets, laptops, smartphone, and educational mobile app software. Educational technologies could improve learning achievement and foster technology literacy in the educational context.

Policy makers, administrators, and educators see educational technologies as an important means to enhance and deliver optimal learning outcomes (Males, et al., 2017). E-learning and M-learning represent two paradigms of teaching and learning by integrating and utilizing educational mobile technologies, including the educational app software, into the instruction and curriculum.

Studies have shown educational mobile app software could provide opportunities for students to acquire digital literacy skills and have a positive impact on student achievement. Research also suggests public schools should value the role of educational technologies to foster the student-centered learning process and to develop 21st century skills in the educational context (Kong, et al., 2014). Educational technologies comprise artifacts such as tablets, smartphones, laptops, and software that could augment and underpin teaching to enhance learning outcomes.

The purpose of this mixed methods study was to employ the ISTE standards as taxonomy to classify educational mobile app software and empirically examine the influence on students' technology literacy. The widely adopted ISTE Standards for Students were employed as taxonomy to classify, and as an assessment standard to underpin and interweave all methodological variables in this study.

Theoretical Framework

The theoretical frameworks of this study are supported by situated learning theory, anchored instruction theory, and social cognitive theory. Situated learning theory emphasizes that learning is a function of the activity, context, and culture in which it is situated (Lave & Wenger, 1991). Anchored instruction learning is a general theory of knowledge acquisition in learning environments that permit learners to explore problems

and utilize knowledge as tools from multiple perspectives (Cognition and Technology Group at Vanderbilt, 1990). Social interaction is a critical component of the situated learning theory in which learners form the community of practice to embody learning behaviors and beliefs (Suchman, 1987).

Situated learning theory argued learners acquired skills through learning activities. Using educational technologies, students could be situated in the technological context doing and participating in learning activities as opposed to the teacher-center classroom setting. Lave and Wenger (1991) asserted learning is an integral part of cultural practice.

Anchored instruction theory advocates that learning embraced in the realistic and authentic context, such as the multi-media setting, to provide the required data and environment to engage in problem solving learning where students connect existing experiences and construct new knowledge (Cognition and Technology Group at Vanderbilt, 1990). It was asserted anchoring or situating instruction in the technology-enabled context, such as videodisc-based environments, could provide many benefits in developing problem-solving skills. Kozma (1991) defined multimedia as a set of elements, such as words, pictures, or video that could be used to represent and process information from the medium. Multimedia brings advantages of these individual elements and provides a single instructional environment to facilitate learning.

Social cognitive theory advocates that social interaction is an integral part of developing cognition (Vygotsky, 1980). It emphasizes that the social behavior of the learner attains the cognitive development. This theory denoted learning is socially and culturally mediated. Students learn through social interactions and develop social

cognition in the social environment. Development of all human activity is mediated by tools, which include cultural and social artifacts. In the context of social learning using technologies, students use educational mobile app software to interact and collaborate with others and develop their social cognitive skill. Educational mobile app software provides affordances to produce social artifacts, such as documents and multimedia files, and share with other students by collaboratively accomplishing a common learning goal. When learners engage in collaboration, information negotiation, idea exchange, or discussion, they develop cognition or skill through cultural and external artifacts. The artifacts utilized by learners in this study were educational apps. Social cognitive theory emphasizes external support on cognitive development. When using educational apps, students collaborate and interact socially as a community of practice and become an integral part of the learning environment. Situated learning theory, anchored instruction theory, and social cognitive theory scaffold the theoretical framework for this study.

Conclusion

This chapter presented a review of relevant literature related to the purpose of this study. The literature review focused on topics relevant to the influence of educational software on students' achievement related to technology literacy skills. In Chapter III, the methodology used to examine the influence of educational software on student technology literacy is explained. It begins with a discussion of the research purpose and design followed by a description of the data collection and analysis strategies.

CHAPTER III

METHODOLOGY

The purpose of this mixed methods study was to employ the International Society for Technology in Education (ISTE) standards as taxonomy to classify educational mobile app software and empirically examine the influence on students' technology literacy. Quantitative data were collected using the *Educational Mobile App Software Categories and Usage Survey* from a purposeful sample of 5th grade teachers at 19 Title I elementary schools located within a large suburban school district in southeast Texas. In addition, students' technology literacy was assessed using the TechLiteracy Assessment (TLA). The quantitative data were analyzed using the mean values and Pearson's Product Moment Correlations (r), while the qualitative data collected from individual interviews and focus groups were analyzed by using an inductive coding process. This chapter presents an overview of the research problem, operationalization of theoretical constructs, research purpose and questions, research design, population and sampling, instrumentation, data collection procedures, data analysis methods, validity, privacy and ethical considerations, and the research design limitations for this study.

Overview of the Research Problem

As educational technologies such as mobile devices and educational software are transforming the learning process, it is imperative to examine how they influence students' technology literacy (Hutchison, Beschorner, & Schmidt-Crawford, 2012). To examine their influence, the categories and characteristics of educational software need to

be classified. However, the challenge has been the difficulty with lack of a taxonomy that could be used to effectively classify and evaluate educational apps. The most serious issue in mobile learning is that there is a lack of a solid theoretical framework to guide teachers' instructional design and to evaluate the effectiveness of the mobile software (Park, 2011).

To examine the influence on student's technology literacy, educational mobile application (app) software needs to be classified. There has been some literature related to the development of taxonomies for educational objectives (Cherner, Dix, & Lee, 2014; Hirch-Pasek, et al., 2015; Hwang & Wu, 2014; Nickerson, Varshney, & Muntermann, 2013; Notari, Hielscher, & King, 2016; Shroff, Keyes, & Linger, 2015; Shuler, 2012; Walker, 2011; Zydney & Warner, 2016). Some of these taxonomies were based on learning theories such as behaviorism or constructivism or cognitive process dimension such as analyze or evaluate. A few taxonomies were based on teacher-centered instruction as opposed to learner-centered instruction. These taxonomies share some commonalities and discrepancies. Much research has been completed on comparing or evaluating software in their design, development, affordances, user interface (e.g., screen color, size, fonts), customization and adaptability, curriculum, learning experiences, or authenticity.

However, the challenge has been difficult with the lack of a taxonomy that could be used to rigorously and effectively classify and evaluate educational apps. Murray and Olcese (2011) concluded it would be difficult for an average user or a K-12 educator with specific instructional needs to find a relevant educational software by searching the categories classified in the various software stores. Additionally, there is no known

empirical study that examines the influence of educational software on student technology literacy.

Operationalization of Theoretical Constructs

This study comprised four constructs: (a) educational mobile app software, (b) educational mobile app software categories, (c) technology literacy, and (d) technology literacy strands. Educational mobile application software is defined as a software program in small size developed for mobile devices in the educational context that is readily download, installed, and immediately engaged to perform a specific function without rebooting the device. Educational mobile app software categories refer to characteristics of educational software classified by a taxonomy using a set of common vocabularies. For the purpose of this study, the ISTE Standards for Students were employed as a taxonomy to classify educational apps. The seven categories of the 2016 ISTE Standards for Students include empowered learner, digital citizen, knowledge constructor, innovative designer, computational thinker, creative communicator, and global collaborator. The *Educational Mobile App Software Categories and Usage Survey* was administered to determine the names and categories of the educational software used in each school.

Technology literacy is defined as the ability to responsibly use appropriate technology and ability to perform tasks and solve problems in dimensions, such as information, communication, ethics and social impact including skills such as accessing, evaluating, and organizing information, researching, problem solving, collaborating, socializing, and communicating. For the purpose of this study, technology literacy strands refer to the literacy in database, multimedia and presentations, social and ethical,

spreadsheets, systems and fundamentals, telecommunication and internet, and word processing. The TechLiteracy Assessment (TLA) was administered to measure student's technology literacy in these seven strands. The ISTE Standards of Students interweave and underpin both the independent and dependent constructs of this study.

Research Purpose, Questions, and Hypotheses

The purpose of this mixed methods study was to employ the ISTE standards as a taxonomy to classify educational mobile app software and empirically examine the influence on students' technology literacy. The following nine research questions guided this study.

1. Are higher TLA scores reflective of the categorical choices of educational mobile app software used in the classrooms at 19 Title I elementary schools?

   Ha: Higher TLA scores are reflective of the categorical choices of educational mobile app software used in the classrooms at 19 Title I elementary schools.

2. Is there a statistically significant relationship between overall school TLA scores and average frequency of use of educational mobile app software at 19 Title I elementary schools?

   Ha: There is a statistically significant relationship between overall school TLA scores and average frequency of use of educational mobile app software at 19 Title I elementary schools.

3. Are teachers predominately or preferably using educational mobile app software in certain categories?

4. What are teachers' perceptions of the influence of integrating educational mobile app software on students' technology literacy?
5. What are teachers' perceptions of the decision processes, methods, and criteria to search, identify, classify, and select educational mobile app software?
6 What are teachers' perceptions regarding the ease of obtaining and integrating educational mobile app software?

Research Design

This study employed a mixed methods research design. This approach allowed the researcher to collect both qualitative and quantitative data sequentially (Creswell, 2013). This design also provided a more thorough view of the data collected by following up the quantitative portion of the study with a qualitative phase that looked for emergent themes to corroborate the findings through triangulation of data to answer the research questions from different perspectives. A purposeful sample of fifth grade teachers at 19 Title I elementary schools located within a large suburban school district in southeast Texas were solicited to provide responses to the *Educational Mobile App Software Categories and Usage*. Individual interviews and focus groups were conducted to gather information pertaining to teachers' perceptions of the influence of educational software on students' learning outcomes. The TechLiteracy Assessment (TLA) was administered to all 5th grade students to measure students' technology literacy. Quantitative data were analyzed using means and Pearson's Product Moment Correlations (r), while the qualitative data were analyzed using an inductive coding process.

Population and Sample

Schools classified as Title I are campuses with a student population of at least 40 percent identified as low-income status (TEA, 2016). Title I is a federal program that provides funds to school districts and schools with high numbers of high percentages of economically disadvantaged students. The population of this study comprised all 19 Title I elementary schools located within a large suburban school district in southeast Texas. There were over 11,750 students and 837 teachers across 19 Title I elementary schools. According to the Texas Education Agency (TEA) Division of Grants Administration Campuses Served with Title I, Part A Funding Fiscal Year 2016 report (TEA, 2016a), the low-income percentage and the economically disadvantaged percentage for 19 Title I elementary schools in southeast Texas are illustrated in Table 3.1. The average low-income percentage within 19 Title I schools was 76.9% and the average economically disadvantaged percentage was 75.0%. The District wide average economic disadvantage percentage was 33.7%.

Table 3.1

Low-Income Percentage and Economically Disadvantaged Percentage at 19 Title I Elementary Schools (2015-2016)

Title I Schools	Low-Income Percentage (%)	Economically Disadvantaged (%)
1	80.4	75.8
2	85.4	85.1
3	87.2	88.9
4	82.5	85.6
5	75.4	76.0
6	65.5	65.1
7	94.1	91.0
8	80.3	78.8
9	80.0	78.3
10	64.9	64.3
11	74.2	71.9
12	75.4	75.0
13	66.0	62.9
14	71.5	71.6
15	71.4	68.0
16	67.2	63.7
17	86.3	83.6
18	68.0	66.0
19	86.1	73.3
Average	77.0	75.0

Note. The Texas Education Agency (2016) reporting website, https://rptsvr1.tea.texas.gov/perfreport/tapr/index.html.

According to the 2015-2016 Student Enrollment Reports (Texas Education Agency, 2016), the average student race/ethnicity at 19 Title I elementary schools was African American (44.8%), American Indian or Alaska Native (0.2%), Asian (4.5%), Hispanic (45.2%), Pacific Islander (0.2%), Two or More Races (1.5%), and White (3.1%). The student demographic data at 19 Title I elementary schools are illustrated in Table 3.2.

Table 3.2

Percentage of Students' Race/Ethnicity 19 Title I Elementary Schools and District Level (2015-2016)

Title I Schools	African American (%)	American Indian (%)	Asian (%)	Hispanic (%)	Pacific Islander (%)	Two or More Races (%)	White (%)
1	52.5	0.2	0.8	44.1	0.3	1.6	0.5
2	52.2	0.6	0.3	44.3	0.2	0.6	1.8
3	32.0	0.4	0.0	66.0	0.0	1.3	0.3
4	74.8	0.2	0.0	22.1	0.0	2.5	0.5
5	13.9	0.7	9.2	67.6	0.1	0.8	7.7
6	65.7	0.2	1.7	21.8	0.2	3.9	6.5
7	41.8	0.6	0.0	55.1	0.2	0.5	1.8
8	21.7	0.3	4.4	64.6	0.0	2.3	6.7
9	85.6	0.5	0.2	9.2	0.7	0.0	3.9
10	41.0	1.6	15.0	36.1	0.4	2.4	3.4
11	30.3	4.3	10.7	48.9	0.0	1.4	4.4
12	86.7	0.4	0.2	11.0	0.2	0.7	0.9
13	22.3	0.1	20.8	50.1	0.0	2.1	4.7
14	42.0	0.9	0.4	52.6	0.3	1.9	1.9
15	58.4	0.8	0.5	37.9	0.0	1.1	1.4
16	43.2	0.5	15.2	35.4	0.3	2.3	3.2
17	23.6	1.1	4.3	67.6	0.0	0.3	3.1
18	43.8	0.0	0.0	53.1	0.0	1.8	1.3
19	20.2	1.0	1.6	70.7	0.0	0.8	5.8
School Average	44.8	0.8	4.5	45.2	0.2	1.5	3.1
District Average	28.2	0.4	24.6	26.5	0.1	2.8	17.4

Note. The Texas Education Agency (2016) reporting website, https://rptsvr1.tea.texas.gov/perfreport/tapr/index.html

The district wide average student race/ethnicity for 2015-2016 school was African American (28.2%), American Indian or Alaska Native (0.4%), Asian (24.6%), Hispanic (26.5%), Pacific Islander (0.1%), Two or More Races (2.8%), and White (17.4%). The total student counts and gender percentage at 19 Title I elementary schools are listed in Table 3.3.

Table 3.3

Students' Gender at 19 Title I Elementary Schools (2015-2016)

Title I Schools	Total Students	Male	Female	Male (%)	Female (%)
1	632	257	240	40.7%	38.0%
2	614	268	249	43.6%	40.6%
3	765	276	239	36.1%	31.2%
4	468	190	177	40.6%	37.8%
5	784	327	276	41.7%	35.2%
6	471	221	165	46.9%	35.0%
7	613	223	234	36.4%	38.2%
8	720	302	283	41.9%	39.3%
9	406	177	169	43.6%	41.6%
10	480	192	180	40.0%	37.5%
11	670	268	258	40.0%	38.5%
12	508	218	209	42.9%	41.1%
13	683	285	257	41.7%	37.6%
14	445	185	165	41.6%	37.1%
15	685	291	295	42.5%	43.1%
16	709	285	279	40.2%	39.4%
17	666	274	230	41.1%	34.5%
18	583	230	232	39.5%	39.8%
19	934	381	341	40.8%	36.5%
Total	11,836	4,850	4,478		
Average	623	255	236	41.1%	38.0%

Note. The Texas Education Agency (2016) reporting website: https://rptsvr1.tea.texas.gov/adhocrpt/adste.html

The 5th grade students' gender was comprised of 52.0% of male students and 48.0% female students at 19 Title I elementary school in the 2015-2016 school year compared to the district level average percentage of male students (51.9%) and female students (48.1%) as illustrated in Table 3.4.

Table 3.4

Fifth Grade Students' Gender in the District and at 19 Title I Elementary Schools (2015-2016)

		Elementary Students	Male	Female	Male (%)	Female (%)
1	District	32,811	17,016	15,793	51.9%	48.1%
2	Grade 5	5,482	2,849	2,633	52.0%	48.0%

Note. The Texas Education Agency (2016) reporting website: https://rptsvr1.tea.texas.gov/adhocrpt/adste.html

The average percentage of 5th grade teachers' race/ethnicity was African American (44.8%), American Indian (0.2%), Asian (4.3%), Hispanic (25.2%), Pacific Islander (0.1%), Two or More Races (1.5%), and White (23.8%). The 5th grade teachers gender comprised 12.0% of male teachers and 88.0% female teachers at 19 Title I elementary school in the 2015-2016 school year compared to the district level average percentage of male teachers (22.9%) and female teachers (77.1%) as illustrated in Table 3.5. A purposeful sample of 5th grade teachers at 19 Title I elementary schools were solicited to participate in this study.

Table 3.5

Teachers' Race/Ethnicity and Gender at 19 Title I Elementary Schools and District Level (2015-2016)

Title I Schools	African American (%)	American Indian (%)	Asian (%)	Hispanic (%)	Pacific Islander (%)	Two or More Races (%)	White (%)	Male (%)	Female (%)
1	50.1	0.0	2.3	32.7	0.0	2.3	12.6	16.4	83.6
2	58.5	0.0	2.3	25.3	2.3	0.0	11.6	16.2	83.8
3	35.6	0.0	2.1	43.9	0.0	2.1	16.3	23.8	76.2
4	74.2	0.0	7.8	6.7	0.0	3.4	7.9	6.7	93.3
5	28.6	0.0	5.4	25.5	0.0	1.8	38.7	5.4	94.6
6	66.4	0.0	5.7	5.7	0.0	0.0	22.2	6.3	93.7
7	60.8	0.0	2.2	36.7	0.0	0.0	0.3	32.7	67.3
8	18.4	0.0	7.4	36.3	0.0	1.8	36.1	14.7	85.3
9	86.4	0.0	10.1	0.0	0.0	0.0	3.6	6.9	93.1
10	13.1	0.0	0.0	18.4	0.0	0.1	68.4	10.6	89.4
11	11.9	2.0	4.0	33.8	0.0	4.0	44.3	12.0	88.0
12	88.6	0.0	0.0	5.4	0.0	0.0	6.0	8.3	91.7
13	12.2	0.0	4.1	20.3	0.0	0.0	63.5	4.1	95.9
14	55.2	0.0	3.1	12.4	0.0	9.2	20.2	6.5	93.5
15	57.3	0.0	4.2	29.5	0.0	0.0	9.0	21.3	78.7
16	24.3	2.0	8.1	21.0	0.0	0.0	44.5	15.0	85.0
17	18.6	0.0	6.6	45.1	0.0	2.2	27.5	4.4	95.6
18	54.0	0.0	4.7	36.5	0.0	2.3	2.4	7.2	92.8
19	36.8	0.0	1.7	44.0	0.0	0.0	17.5	8.8	91.2
School Average	44.8	0.2	4.3	25.2	0.1	1.5	23.8	12.0	88.0
District Average	28.5	0.2	5.4	13.7	0.3	2.1	50.0	22.9	77.1

Note. The Texas Education Agency reporting website, https://rptsvr1.tea.texas.gov/perfreport/tapr/index.html)

Participant Selection

The data collected from item 2 on the *Educational Mobile App Software Categories and Usage Survey, How many educational Software do you use in the 2016-2017 school year?,* were aggregated to the school level by dividing the total number of educational software used and the number of teachers responding to the online survey. This data represented the average number of educational software used at each of the 19 Title I elementary schools. Fifth grade teachers at the schools with higher average number of educational software used were asked to participate in follow-up interviews and focus groups. Teachers who integrated more educational mobile app software could provide more in-depth perceptions of the interview questions (see page 98 – 139).

Instrumentation

Thorough research could not identify any established instruments for examining the influence of integrating educational mobile app software on students' technology literacy. It resulted in the need of the development of a new web-based instrument. The following section described the process of developing the *Educational Mobile Application Software Categories and Usage* survey employed in this study.

Educational Mobile Application Software Categories and Usage Survey

This study employed the *Educational Mobile Application Software Categories and Usage Survey* to collect data from a purposeful sample of 5th grade teachers at 19 Title I elementary schools for the constructs of this study including numbers, names, categories, frequency of use, and perceptions pertaining to the integration of educational mobile app software used in their classrooms. This survey was developed following a process to ensure accuracy and validity through consultation with experts and member

checking. The first step in creating the instrument was to determine if the problem had merit and to create survey items. An analysis of the various types of constructs resulted in the identification of three sections: (a) Educational Mobile App Software Related Questions; (b) Perceptions Related Questions; and (c) General Questions.

The next step in developing this survey was to establish the content validity of the instrument. Rubio, Berg-Weger, Tebb, Lee, and Rauch (2003) suggested that content validity refers to as the extent to which how well items on a measure assess the content. The authors asserted a panel of experts could provide constructive feedback about the quality of instrumentation. Davis (1992) stated that content validity could be established by having the survey instrument reviewed by a panel of content experts. A panel of experts was assembled to establish the content validity of this survey. Invitation emails were sent by the Chair of the dissertation committee to a group of content experts. Eleven experts participated in reviewing this survey and provided comments and feedback. The panel comprised dissertation committee members, university professors, campus administrators, and technology specialist. The demographic information of content experts that participated in the panel is illustrated in Table 3.6. The feedback from the panel guided the revision of this survey instrument.

Table 3.6

Demographics of Content Experts that Participated in the Panel

Category	Frequency (n)	Percentage (%)
Dissertation Committee Members	4	36
University Professors	2	19
Campus Administrators	4	36
Technology Specialist	1	9

A member of the panel expressed the concern to specifically list the school year so the respondents could focus on the educational mobile app software used only in this specified school year. Another member recommended listing the frequency of use in a descending order and grouping similar responses together. This could prevent respondents from selecting wrong option. For the number of educational mobile app software used, a panel member suggested using a range of numbers rather than a single digital numbers. Another member suggested replacing “Language Art” with “English Language Art” to avoid the confusion of other languages, such as Spanish or French. Another member suggested revising the question for Item 5 and adding the word “appropriate” to ensure respondents selected the most appropriate responses pertaining to the categories of educational mobile app software used. One committee member suggested adding an example of descriptors in a rubric for Item 6. Another committee member advised to use 4-point Likert scale rather than 5-point one to avoid the neutral responses. Additional comments included a suggestion to bold all of the numbers (or none), italicize the information under item 2, don’t end a question in a preposition, remove extra space and comma, and remove the word “the” before the word “core” from item 10. A panel member suggested making responses to all items optional except for Item 1 and 2 to prevent participants from stopping if they integrated less educational mobile app software.

In addition, the Institutional Review Board (IRB) committee at the district studied also reviewed and commented on some items of this survey. It was suggested that items pertaining to the demographic information could potentially reveal the identity of the respondents and do not maintain anonymity due to identifiable questions asked of

participants. Two items for gender and race/ethnicity information were removed from the survey.

For the final validation, an email with the URL to the revised online survey was sent to the experts. An associate professor at the College of Education suggested adding a clear explanation and definition of the categories on all the app pages. A figure of seven categories of the ISTE standards (see Figure 2.1) was added to the pages for all five apps related items. One of the committee members commented that the final version of the instrumentation was much clearer and meaningful with the added definitions. The final version of the survey was approved by the panel before it was administered to the participants.

The final version of the survey comprised three sections with 10-items: Section 1 Educational Mobile App Software Related Questions (5-items), Section 2 Perceptions Related Questions (3-items), and Section 3 General Questions (2-items). The survey instrument for this study is attached as Appendix B. Section 1 is the information regarding the name, frequency of use, and categories pertaining to each app. Section 2 contains the questions related to the perceived effectiveness of teaching with educational mobile application software and usefulness of having a rubric to identify and evaluate appropriate educational mobile application software. These questions are scored on a 4-point Likert-type scale (1 = Strongly disagree, 2 = Disagree, 3 = Agree, 4 = Strongly agree). Section 3 is the general information regarding the years of experiences in teaching and core subject areas of teaching in the 2016-2017 school year. The constructs and related items of survey are described next.

Item 1, *please select your school.* was used to determine the name of the school at which the respondent was located at. Item 2, *How many total educational apps did you use in the 2016-2017 school year?,* was used to determine how many educational mobile app software the respondent used at each school. The average number and frequency of use of educational mobile app software integrated were aggregated to the school level. Item 3, *What is the name of the app?,* was used to determine the name of each educational mobile app software used. Item 4, *How often do you use this app?,* was used to determine how often the software was used in classroom. Item 5, *Please select most appropriate category(ies) for this app. Select all that apply,* was used to classify each educational mobile app software into seven categories of the ISTE standards. Item 6 to 8 were 4-point Likert scale questions were used to assess teachers' perceptions pertaining to the perceived influence of integrating educational mobile app software on students' technology literacy, perceived challenges of evaluating and selecting educational mobile app software, and perceived usefulness of using a rubric to identify, select, and evaluate educational mobile app software. Item 9 and 10 were used to determine years of teaching experience and core subject areas. The alignment between each survey items and the respective constructs are illustrated in Table 3.7.

Table 3.7

Alignment between Survey Items and Constructs

Construct	Question Number
Educational Mobile App Software	1, 2, 3, 6, 7, 8
Educational Mobile App Software Categories	4, 5

TechLiteracy Assessment (TLA)

The TLA is a web-based assessment tool designed by Learning.com to authentically assess students' technology knowledge and skills using the skill modules. The TLA earned the ISTE Seal of Alignment for ISTE NETS-S standard (Roland, 2006) which was a rigorous review by experts awarded to high-quality products and services aligned with ISTE Standards. The validity of the TLA assessment was established by a field test of over 8,000 students from 68 schools in seven districts in 2005 (Judson, 2010). The TLA employs a criterion-referenced standard and the Angoff Standard Setting Method recognized as a statewide educational achievement tests methodology to provide the reliability for the assessment (Hill & Heard, 2010). Roland (2006) stated that the TLA was the only tool suited to assess younger student's technology literacy. The TLA has being administered annually to all 5th grade students at the school studied since 2008.

The TLA was designed to measure students' foundational digital skills. The types of assessment questions comprise multiple choice and interactive items. Scores could be analyzed to evaluate student's proficiency comparing to standard, school average, district average, and/or the average of all other students nationwide. The online TLA assessment comprises a mix of performance and knowledge based items with seven skill modules to assess fifth grade student's technology literacy including (a) database, (b) multimedia and presentations, (c) social and ethical, (d) spreadsheets, (e) systems and fundamentals, (f) telecommunication and internet, and (g) word processing. Raw scores from these skill modules indicate the number of items correct out of the possible number of items, with an overall possibility of a total items correct. For the purpose of this study to examine the

influence of educational software on students' technology literacy, the TLA was administered to assess students' technology literacy.

Data Collection Procedures

Approval was granted by the UHCL's Committee for Protection of Human Subjects (CPHS) before any data were collected. Following the approval of CPHS, the Research Review Board at the district studied was contacted to grant permission on administering the survey and conducting individual interviews and focus groups. An email was sent to all 5th grade core subject teachers. The email included a survey cover letter stating the purpose of the study, the participation in this study was voluntary, and all data and responses would remain completely anonymous (see Appendix A). A link to access the online survey using Qualtrics was included in the email. The TLA was administered by Learning.com to all 5th grade students between April and May to assess the students' technology literacy. The researcher collected the TLA raw test scores from the retrieve score reports page on Learning.com web site (Learning.com, 2017).

The data collected from item 2, *How many educational mobile application software did you use in the 2016-2017 school year?*, were aggregated to the school level to represent the average number of educational software used for each school. The fifth grade teachers at the schools with higher average number of educational software used were contacted to participate in individual interviews or focus groups. A separate email was sent to the participants with the informed consent letter (see Appendix C) stating the purpose of the study and that the participation was completely voluntary. Each individual interview lasted approximately one hour and each focus group session lasted approximately two hours. All individual interview and focus group sessions were held on

participants' campuses after school hours to minimize the impact on teachers' instructional time which was advocated by the Research Review Board at the district studied. All sessions were digitally recorded and transcribed.

Semi-structured interview questions guided the individual interviews and focus groups. There were five probing interview questions each with three to four sub questions (see Appendix D). The topics to be covered in the individual interviews and focus groups were comprised of perceived effectiveness of taxonomy for classifying educational software and perceived influence of educational software on students' learning outcomes. There were three to five interview questions for each topic such as: *What are your thoughts on how apps are organized and classified in app stores, How important it is to embody one well-established and adopted standard that can interweave all variables across the board*, and *What is your perception of using apps to foster learning*. The data collected were stored on the password protected hard drive on the researcher's home computer and a separate password protected Universal Serial Bus (USB) memory drive. It continues to be maintained confidentially for five years following the conclusion of the research before it is destroyed once the deadline has passed.

Data Analysis

Quantitative

IBM SPSS was used to analyze the survey and TLA data. To answer research questions one and two, Pearson's Product-Moment Correlations (r) were used to determine if there is a statistically significant relationship between the seven categories of educational mobile app software: empowered learner, digital citizen, knowledge constructor, innovative designer, computational thinker, creative communicator, and

global collaborator (independent variables) and students' TLA scores in each of the seven technology literacy strands: database, multimedia and presentations, social and ethical, spreadsheets, systems and fundamentals, telecommunication and internet, and word processing (outcome variables) at 19 Title I elementary schools. TLA scores were measured by the online TLA assessment tool with seven literacy modules. Education mobile apps software categories were measured by the responses to Item 5 on the Educational Apps Categories and Usage Survey and aggregated to the school level. To answer research question three, the mean value was used to determine which categories of educational mobile app software in which participants integrate more frequently. Frequency of use was measured by the responses to Item 4 on the *Educational Mobile Application Software Categories and Usage Survey* and aggregated to the school level. A statistical significance value of .05 was used for this study. Cohen's d and coefficient of determination (r^2) were utilized to calculate effect sizes (Cohen, 1988).

Qualitative

To address research questions four through six, an inductive coding process was used to identify emergent themes and patterns pertaining to the participants' responses from the individual interviews and focus groups. Individual interviews and focus groups were digitally recorded and transcribed to ensure all responses were analyzed during the coding process. The researcher analyzed the data based on the notes taken right after the individual interviews and focus groups, listening to the digital recordings and reading the transcripts. The researcher transcribed the voice recordings of individual interviews and focus groups and performed open coding using the qualitative data analysis software NVivo 11 (QSR International Pty Ltd., 2016).

In the data reduction phase, the researcher organized the data to establish themes and patterns that emerged from the participants' responses. The transcriptions from the individual interviews and focus groups were imported into NVivo for open coding. Central themes and patterns were established by looking for redundancy among the responses from the individual interviews and focus groups. Prominent themes and patterns were analyzed and compared among the individual interviews and focus group sessions using the constant comparative method. The overarching themes developed from the refined emerging patterns represented the participants' perceptions and were interpreted to draw conclusions to provide an in-depth understanding of the influences of integrating educational mobile app software on students' technology literacy.

Validity

Qualitative validity was established by performing triangulation, member checking, and peer review to improve the accuracy, validity, and transferability of the data. Data triangulation was established by collecting data from multiple methods and multiple participants including the online survey, individual interviews, and focus groups. During the data collection phase, individual interviews and focus groups were recorded and transcribed verbatim to ensure that all responses were examined and analyzed. The researcher organized the responses into emergent themes to gauge validity based on data saturation and fit. The researcher used member checking by getting feedback from the participants to validate the data. This was accomplished by giving the participants an opportunity to confirm particular aspects of the findings, correct any errors or wrong interpretations. Peer reviewing was performed on the findings of this study to ensure bias was minimized during the data analysis phase.

Privacy and Ethical Considerations

The researcher submitted the application form to gain approval from the UHCL's CPHS and from the participating school district's Research Review Board before administrating the online survey or collecting any data. Prior to administering the survey, an invitation email was sent to all 5th grade teachers at 19 Title I elementary schools with a cover letter (see Appendix A) stating the purpose of the study, ensuring participation was completely voluntary, and their responses and identities remain completely confidential and anonymous. Completion of the online survey by participants implied their consent.

Prior to conducting the individual interviews and focus groups, all participants were provided with a consent form (see Appendix C) detailing the purpose of the study, the acknowledgement of completely voluntary participation, and ensuring complete confidentiality. To protect the confidentiality of the participants of this study, pseudonyms were assigned to participants. The researcher requested that the participants of the focus groups did not share participants' responses outside of the focus groups. During the individual interview and focus group sessions, every attempt was made to stay as neutral and objective as possible and not to impose personal beliefs upon any of the participants. All information was transcribed from the audio recording to provide utmost accuracy and to establish both the internal and external validity of the study.

During the coding phase, every attempt was made to maintain as objective as possible and to continuously safeguard against unsupported and subjective interpretations as themes emerged. At all times, all collected data and informed consent forms were stored on the researcher's home computer hard drive and an additional copy on a separate

Universal Serial Bus (USB) memory drive secured by the researcher. The researcher continues to keep all data protected in a filing cabinet in a locked storage facility and ensured that all electronic data remain password protected on storage devices for five years after the study had been completed. At the culmination of the fifth year, the data will be destroyed then. There were no obvious undue risks endured by any of the participants in this study.

Research Design Limitations

There were several potential limitations to be considered for this study. First, the students' technology literacy was assessed by the TLA in seven strands: (a) database, (b) multimedia and presentations, (c) social and ethical, (d) spreadsheets, (e) systems and fundamentals, (f) telecommunication and internet, and (g) word processing. Therefore, the findings on how educational software influence students' technology literacy were limited to these seven strands. For this reason, caution should be considered when generalizing the influence of educational software to other technology literacies, such as graphic and imaging skills or keyboarding skills.

Second, the self-report nature of the online survey, individual interviews, and focus groups were a limitation. Bertrand and Mullainathan (2001) asserted cognition and social desirability could play a crucial role in shaping the responses and answers to subjective items on surveys and interview questions in interviews. In addition, Wilson and Zietz (2004) attempted to analyze to which extent self-reported data were biased. The authors suggested that reposting bias existed pertaining to the types of school and sensitivity of the measured variables to be measured. The authors concluded that self-reported data collected from respondents indicated a greater bias on sensitive variables.

The variables to be measured in this study, such as names of the educational software used, frequency of use, and perceived influence, could be sensitive to some survey respondents. Therefore, the self-reported bias was considered as a limitation of this study. Since there was no guarantee that participants provided accurate information, misrepresentation should be considered when generalizing the findings to other demographic populations.

Third, rather than randomly selecting participants, the participants for this study were purposefully selected 5th grade teachers from 19 Title I elementary schools located within a large suburban school district in southeast Texas. This was the third limitation to generalizing the findings to other populations or school districts. The fourth limitation pertains to the population studied. The target population was all 19 Title I elementary schools to participate in this study. The purpose of focusing on this group was to minimize the influence of using educational software outside the classrooms based on lower average family income status and lower ownership of technologies. Caution should be considered when generalizing the findings of this study to other populations.

Conclusion

This chapter presents an overview of the research methodology for this study. The purpose of this mixed methods study was to employ the ISTE standards as a taxonomy to classify educational mobile app software and empirically examine the influence on students' technology literacy. A mixed methods design was employed to answer the research questions. A purposeful sample of fifth grade teachers were asked to participate in this study. The researcher administered an online survey and conducted follow-up interviews and focus groups. Quantitative data collected from a purposeful sample of

fifth grade core subject teachers were analyzed using means and Pearson's Product Moment Correlations (r). Qualitative data were be transcribed and an inductive coding process was used to identify key themes and patterns. Results of this mixed methods study were discussed in detail in the next chapter.

CHAPTER IV

RESULTS

The purpose of this mixed methods study was to employ the ISTE standards as a taxonomy to classify educational mobile app software and empirically examine the influence on students' technology literacy. The ISTE Standards for Students were employed as a taxonomy to classify educational mobile application (app) software into seven categories: empowered learner, digital citizen, knowledge constructor, innovative designer, computational thinker, creative communicator, and global collaborator. Students' technology literacy was assessed by TechLiteracy Assessment (TLA) in seven strands: database, multimedia and presentations, social and ethical, spreadsheets, systems and fundamentals, telecommunication and internet, and word processing.

Quantitative data were collected using a researcher-constructed *Educational Mobile Application Software Categories and Usage* Survey. Qualitative data were collected by conducting semi-structured interviews and focus groups. Results of the data analysis were triangulated by utilizing both quantitative and qualitative data from multiple sources and participants to examine the influence of educational mobile app software on students' technology literacy in all 19 Title I elementary schools at a suburban school district in southeast Texas. This chapter provides the detailed results of the data analysis of both the quantitative and qualitative data obtained for the study. The results of the data analysis for each of the six research questions are provided below. The chapter concludes with a summary of the qualitative and quantitative findings.

Participant Demographics

There were total 85 fifth grade core subject teachers at 19 Title I elementary schools working in the participating school district during the 2016-2017 academic school year. Of those, 63 teachers completed the survey (74.1% response rate). The years of teaching experience of survey participants are illustrated in Table 4.1. The percentages of common core subject areas of 63 participants were mathematics (30.2%), science (29.4%), English language arts (23.8%), and social studies (16.7%) as illustrated in Table 4.2. Sixteen fifth grade core subject teachers participated in a semi-structured interview and/or focus group session. The gender and years of teaching experience of interviewees were discussed in research questions four.

Table 4.1

Years of Teaching Experience of Survey Participants

	Frequency (n)	Percentage (%)
1 to 5 Years	16	25.4
6 to 10 Years	20	31.7
11 to 20 Years	15	23.8
More than 20 Years	12	19.0

Table 4.2

Common Core Subject Teachers of Survey Participants

Common Core Subjects	Percentage (%)
Mathematics	30.2
Science	29.4
English Language Arts	23.8
Social Studies	16.7

Research Question One

To answer research question one, *Are higher TLA scores reflective of the categorical choices of educational mobile app software used in the classrooms at 19 Title I elementary schools?*, a Pearson's Product Moment Correlation (*r*) was used to determine whether a relationship existed between students' technology literacy scores and categories of educational mobile app software. Students' technology literacy scores were assessed in seven strands: database, multimedia and presentations, social and ethical, spreadsheets, systems and fundamentals, telecommunication and internet, and word processing. The categories of educational mobile app software were classified by ISTE Standards for Students into seven categories: (a) empowered learner, (b) digital citizen, (c) knowledge constructor, (d) innovative designer, (e) computational thinker, creative communicator, and (f) global collaborator. Table 4.3 provides data on the relationship between technology literacy and the seven categories of educational mobile app software. The following sections present the findings of the statistically significant correlations relationships between technology literacy and the seven categories of educational mobile app software integrated in their classrooms at 19 Title I elementary schools in more detail.

Table 4.3

Relationship between Students' 2016-2017 TLA Scores and the ISTE Categories

		Categories of Educational Mobile App Software						
Technology Literacy		Empowered Learner	Digital Citizen	Knowledge Constructor	Innovative Designer	Computational Thinker	Creative Communicator	Global Collaborator
Database	Pearson Correlation	.068	.032	.212	.170	.503	.344	.309
	p-value	.783	.898	.384	.487	.028*	.149	.197
Multi-media Presenta	Pearson Correlation	.249	.281	.671	.102	.454	.397	.434
	p-value	.304	.243	.002*	.678	.051	.093	.063
Social Ethical	Pearson Correlation	.157	.054	.493	.117	.399	.233	.087
	p-value	.522	.825	.032*	.633	.090	.337	.722
Spread sheets	Pearson Correlation	.184	.159	.512	.061	.473	.407	.444
	p-value	.450	.514	.025*	.805	.041*	.084	.057
System Fundamentals	Pearson Correlation	.093	.082	.323	.094	.482	.290	.207
	p-value	.706	.740	.177	.703	.037*	.229	.396
Tele-comm Internet	Pearson Correlation	.125	.215	.679	.146	.454	.510	.346
	p-value	.611	.376	.001*	.552	.051	.026*	.146
Word Process	Pearson Correlation	.133	.019	.519	.132	.507	.326	.406
	p-value	.587	.939	.023*	.590	.027*	.173	.085

*Statistically significant ($p<.05$)

Database

A sub-question, *Are higher database literacy scores reflective of categorical choices of educational mobile app software?,* was answered using a Pearson's Product Moment Correlation (r) to determine if there was a statistically significant relationship between database literacy scores and the seven categories of educational mobile app software (see Table 4.4). Findings indicated there was a statistically significant correlation between database literacy scores and integration of educational mobile app software in the computational thinker category (r = .503, p = .028, r^2 = .253). Integration of educational mobile app software in the computational thinker category could explain 25.3% of the variation in database literacy scores. As teachers integrated more educational mobile app software in the computational thinker category, students' TLA database scores increased.

Table 4.4

Relationship between Database Literacy Scores and Average Educational Mobile App Software Categories Used

Categories	*r*-value	*p*-value*	r^2
Empowered Learner	.068	.783	.005
Digital Citizen	.032	.898	.001
Knowledge Constructor	.212	.384	.045
Innovative Designer	.170	.487	.029
Computational Thinker	.503	.028*	.253
Creative Communicator	.344	.149	.119
Global Collaborator	.309	.197	.096

*Statistically significant (p<.05)

Multimedia and Presentations

A sub-question, *Are higher multimedia and presentations literacy scores reflective of categorical choices of educational mobile app software?,* was answered by

using a Pearson's Product Moment Correlation (r) to determine if there was a statistically significant relationship between multimedia and presentations literacy scores and seven categories of educational mobile app software (see Table 4.5). Findings suggested there was a statistically significant correlation between multimedia and presentations literacy scores and integration of educational mobile app software in the knowledge constructor category (r = .671, p = .002, r^2 = .450). Integration of educational mobile app software in the knowledge constructor category could explain 45.0% of the variation in multimedia and presentations literacy scores. As teachers integrated more educational mobile app software in the knowledge constructor category, students' TLA multimedia and presentations scores increased.

Table 4.5

Relationship between Multimedia and Presentations Literacy Scores and Average Educational Mobile App Software Categories Used

Categories	*r*-value	*p*-value*	r^2
Empowered Learner	.249	.304	.062
Digital Citizen	.281	.243	.079
Knowledge Constructor	.671	.002*	.450
Innovative Designer	.102	.678	.010
Computational Thinker	.454	.051	.207
Creative Communicator	.397	.093	.157
Global Collaborator	.434	.063	.188

*Statistically significant (p<.05)

Social and Ethical

A sub-question, *Are higher social and ethical literacy scores reflective of categorical choices of educational mobile app software?,* was answered using a Pearson's Product Moment Correlation (r) to determine if there was a statistically significant relationship between social and ethical literacy scores and seven categories of

educational mobile app software (see Table 4.6). Findings suggested there was a statistically significant correlation between social and ethical literacy scores and integration of educational mobile app software in the knowledge constructor category (r = .493, p = .032, r^2 = .243). Integration of educational mobile app software in the knowledge constructor category could explain 24.3% of the variation in social and ethical literacy scores. As teachers integrated more educational mobile app software in knowledge constructor category, students' TLA social and ethical scores increased.

Table 4.6

Relationship between Social and Ethical Literacy Scores and Average Educational Mobile App Software Categories Used

Categories	*r*-value	*p*-value*	r^2
Empowered Learner	.157	.522	.025
Digital Citizen	.054	.825	.003
Knowledge Constructor	.493	.032*	.243
Innovative Designer	.117	.633	.014
Computational Thinker	.399	.090	.159
Creative Communicator	.233	.337	.054
Global Collaborator	.087	.722	.008

*Statistically significant (p<.05)

Spreadsheets

A sub-question, *Are higher spreadsheets literacy scores reflective of categorical choices of educational mobile app software?,* was answered using Pearson's Product Moment Correlation (r) to determine if there was a statistically significant relationship between spreadsheets literacy scores and seven categories of educational mobile app software (see Table 4.7). Findings indicated there was a statistically significant correlation between spreadsheets literacy scores and integration of educational mobile app software in the knowledge constructor (r = .512, p = .025, r^2 = .262) and the

computational thinker (r = .473, p = .041, r^2 = .224) categories. Integration of educational mobile app software in the knowledge constructor and the computational thinker categories could explain the variation in spreadsheets literacy scores 26.2% and 22.4% respectively. As teachers integrated more educational mobile app software in knowledge constructor and computational thinker categories, students' TLA spreadsheets scores increased.

Table 4.7

Relationship between Spreadsheets Literacy Scores and Average Educational Mobile App Software Categories Used

Categories	*r*-value	*p*-value*	r^2
Empowered Learner	.184	.450	.034
Digital Citizen	.159	.514	.025
Knowledge Constructor	.512	.025*	.262
Innovative Designer	.061	.805	.004
Computational Thinker	.473	.041*	.224
Creative Communicator	.407	.084	.165
Global Collaborator	.444	.057	.197

*Statistically significant (p<.05)

Systems and Fundamentals

A sub-question, *Are higher systems and fundamentals literacy scores reflective of categorical choices of educational mobile app software?,* was answered using a Pearson's Product Moment Correlation (r) to determine if there was a statistically significant relationship between systems and fundamentals literacy scores and seven categories of educational mobile app software (see Table 4.8). Findings suggested there was a statistically significant correlation between systems and fundamentals literacy scores and integration of educational mobile app software in the computational thinker category (r = .482, p = .037, r^2 = .232). Integration of educational mobile app software in

the computational thinker category could explain 23.2% of the variation in systems and fundamentals literacy scores. As teachers integrated more educational mobile app software in the computational thinker category, students' TLA systems and fundamentals scores increased.

Table 4.8

Relationship between Systems and Fundamentals Literacy Scores and Average Educational Mobile App Software Categories Used

Categories	*r*-value	*p*-value*	r^2
Empowered Learner	.093	.706	.009
Digital Citizen	.082	.740	.007
Knowledge Constructor	.323	.177	.104
Innovative Designer	.094	.703	.009
Computational Thinker	.482	.037*	.232
Creative Communicator	.290	.229	.084
Global Collaborator	.207	.396	.043

*Statistically significant ($p<.05$)

Telecommunication and Internet

A sub-question, *Are higher telecommunication and internet literacy scores reflective of categorical choices of educational mobile app software?*, was answered using a Pearson's Product Moment Correlation (r) to determine if there was a statistically significant relationship between telecommunication and internet literacy scores and seven categories of educational mobile app software (see Table 4.9). Findings indicated there was a statistically significant correlation between telecommunication and internet literacy scores and integration of educational mobile app software in the knowledge constructor ($r = .679$, $p = .001$, $r^2 = .461$) and the creative communicator ($r = .510$, $p = .026$, $r^2 = .260$) categories. Integration of educational mobile app software in the knowledge constructor and the creative communicator categories could explain the variation in

telecommunication and internet literacy scores 46.1% and 26.0% respectively. As teachers integrated more educational mobile app software in the knowledge constructor and the creative communicator categories, students' TLA telecommunication and internet scores increased.

Table 4.9

Relationship between Telecommunication and Internet Literacy Scores and Average Educational Mobile App Software Categories Used

Categories	*r*-value	*p*-value*	r^2
Empowered Learner	.125	.611	.016
Digital Citizen	.215	.376	.046
Knowledge Constructor	.679	.001*	.461
Innovative Designer	.146	.552	.021
Computational Thinker	.454	.051	.206
Creative Communicator	.510	.026*	.260
Global Collaborator	.346	.146	.120

*Statistically significant ($p<.05$)

Word Processing

A sub-question, *Are higher word processing literacy scores reflective of categorical choices of educational mobile app software?,* was answered using a Pearson's Product Moment Correlation (r) to determine if there was a statistically significant relationship between word processing literacy scores and seven categories of educational mobile app software (see Table 4.10). Findings suggested there was a statistically significant correlation between word processing literacy scores and integration of educational mobile app software in the knowledge constructor ($r = .519$, $p = .023$, $r^2 = .269$) and the computational thinker ($r = .507$, $p = .027$, $r^2 = .257$) categories. Integration of educational mobile app software in the knowledge constructor and the computational thinker categories could explain the variation in word processing literacy

scores 26.9% and 25.7% respectively. As teachers integrated more educational mobile app software in the knowledge constructor and the computational thinker categories, students' TLA word processing scores increased.

Table 4.10

Relationship between Word Processing Literacy Scores and Average Educational Mobile App Software Categories Used

Categories	*r*-value	*p*-value*	r^2
Empowered Learner	.133	.587	.018
Digital Citizen	.019	.939	.000
Knowledge Constructor	.519	.023*	.269
Innovative Designer	.132	.590	.017
Computational Thinker	.507	.027*	.257
Creative Communicator	.326	.173	.106
Global Collaborator	.406	.085	.165

*Statistically significant ($p<.05$)

Research Question Two

To answer research question two, *Is there a statistically significant relationship between overall school TLA scores and average frequency of use of educational mobile app software at 19 Title I elementary schools?*, a Pearson's Product Moment Correlation (r) was used to determine whether a relationship existed between overall school TLA scores and the average frequency of use of educational mobile app software. Average frequency of use of educational apps was aggregated at the school level. A teacher could integrate multiple educational mobile app software and each app could be used in different frequency. Based on how frequently an app was used, a score was assigned. The more frequently an app was used, the higher the score that was assigned. For example, a score of 10 was assigned to a teacher if the app was used "2-4 times a day". Average

frequency of use of educational apps was aggregated at the school level by using the mean value at each school. Table 4.11 illustrates use frequencies and the assigned scores.

Table 4.11

Frequencies of Use of Educational Mobile App Software and Scores

Frequencies of Use of Educational Mobile App Software	Scores
2-4 times a day	10
Once a day	9
2-4 times a week	8
Once a week	7
2-4 a month	6
Once a month	5
2-4 times a semester	4
once a semester	3
2-4 times a year	2
Once a year	1

The average frequency of use for each school was the total scores divided by the number of teachers who responded from the same school. Table 4.12 illustrates that the mean value for the average frequency of use of educational software was 6.1 (n = 19); on average, teachers used educational apps between “Once a week” and “2-4 times a month” in their classrooms. The mean school TLA score was 225.4 (n = 19). Findings from a Pearson’s Product Moment Correlation (r) suggested that there was not a statistically significant relationship between overall school TLA scores and average frequency of use of educational apps in their classrooms at 19 Title I elementary schools in classrooms (r = .181, p = .459). The more frequently educational mobile app software was used in the classroom did not necessarily attribute to higher overall school TLA scores at 19 Title I elementary schools.

Table 4.12

Descriptive Statistics of Average Educational Apps Frequency of Use and Overall School TLA Scores

	Mean	Std. Deviation	N
Average Frequency of Use of Educational Apps	6.1	0.92	19
Overall school TLA Scores	225.4	16.55	19

Research Question Three

To answer research question three, *Are teachers predominately or preferably using educational mobile app software in certain categories?*, the mean value was calculated to determine the teachers' categorical choices of educational mobile app software. The categorical choices of apps were classified into seven categories: (a) empowered learner, (b) digital citizen, (c) knowledge constructor, (d) innovative designer, (e) computational thinker, (f) creative communicator, and (g) global collaborator. Table 4.13 provides data of the mean values suggested that teachers preferably integrated educational mobile app software in knowledge constructor and computational thinker categories.

Table 4.13

The Mean Values of Most Frequently Used Categories of Educational Mobile App Software

Categories	Mean	SD
Empowered Learner	0.72	0.36
Digital Citizen	0.21	0.23
Knowledge Constructor	1.06	0.58
Innovative Designer	0.77	0.30
Computational Thinker	1.03	0.62
Creative Communicator	0.41	0.34
Global Collaborator	0.09	0.16

Findings indicated that the most predominately used categories of educational mobile app software were the knowledge constructor (M = 1.06) and the computational thinker (M = 1.03). Educational apps in the innovative designer, empowered learner, and creative communicator categories were used modestly (M = .77, .72, and .41 respectively). The least frequently used categories of educational mobile app software were the digital citizen (M = 0.21) and global collaborator (M = 0.09) categories.

On average, teachers integrated approximate one educational mobile app software that could be classified in the knowledge constructor and computational thinker categories at 19 Title I elementary schools in their classrooms during the 2016-2017 school year. Teachers integrated average less than one educational app in the innovative designer or empowered learner categories in classrooms. Conversely, educational mobile app software in the digital citizen and the global collaborator categories was rarely integrated in their classrooms.

Research Question Four

Research question four, *What are teachers' perceptions of the influence of integrating educational mobile app software on students' technology literacy?*, was answered by using an inductive coding process to analyze the data collected from the semi-structured interview protocol questions during the individual interviews and focus groups. This question aimed to gain in-depth understanding how teachers perceive the influence of integrating educational mobile app software on students' technology literacy in seven strands: database, multimedia and presentations, social and ethical, spreadsheets, systems and fundamentals, telecommunication and internet, and word processing. Sixteen fifth grade core subject teachers (14 females and two males) from six different Title I

elementary schools participated in a semi-structured interview and/or focus group sessions. The gender data of interview participants is listed in Table 4.14.

Table 4.14

Gender of Interview Participants

	Frequency (n)	Percentage (%)
Female	14	87.5
Male	2	12.5

Participants were asked a question about how do they perceive the influence of integrating educational apps on students' technology literacy. The emergent themes, illustrated by a few samples of the participants' comments, are presented in the following sections.

Teachers' Perceptions of the Influence of Integrating Educational Software

When the participants were asked, "*Could educational mobile app software improve students' technology literacy*?", all participants possessed strong beliefs pertaining to the positive influence of integrating educational mobile app software on students' technology literacy. For example, Debra stated: "Good appropriate educational apps make a huge difference in the classroom." Cynthia commented, "Knowing how interested the students are in technology and if you're pulling in whatever it is you're teaching with that technology, the right apps, and the right curriculum, it will be tremendous."

Participants shared an array of educational mobile app software that they integrated in their classrooms. The most common educational mobile app software integrated by the participants included BrainPOP, Istation, Learning.com, Microsoft

Office Suite®, Reflex Math, Think Through Math (TTM), and STEMscopes. These are the district paid and provided software for all elementary teachers to use in classrooms. Summarized descriptions of these applications are as follows.

BrainPOP is a software that utilizes short videos, animated movies, games, and activities to engage learning. Teachers can stop the videos for students to take notes. There is a quiz at the end of each video to assess if students retained the information. Oprah shared her thoughts on using BrainPOP:

> Those videos that are short, quick, and to the points. It shows the vocabulary. It also has the closed captioning. For those that need assistance with visual. All of that are great things about BrainPOP. The kids like it and they can't wait to do the quiz.

Istation is a district provided software to enhance reading and writing literacy at SISD. It can differentiate the level of literacy skills and utilize lessons that are adequate to the learners. Embedded assessments place each student on a personalized learning path. As Karen pointed out: “Istation could empower learners and scaffold their learning.”

Microsoft Office Suite® is a collection of software that were frequently integrated by the participants in their classrooms to improve student’s technology literacy in word process, spreadsheets, and presentations. It includes Word, PowerPoint, and Excel respectively. Tina asked students to keep a journal on their learning to improve word processing literacy by using Microsoft Word. She commented, “Using Word, students type it out what web site they used, what was the outcome, what was the expectation.” Some fifth grade students become fluent in using these Office software as Debra stated,

“Some of them [students] are really good at using them like PowerPoint and things like that.” Helen also shared a similar comment, saying, “PowerPoint will enable them to explore better ways to improve their presentations.”

Reflex Math is a software that focuses on assessing students’ math facts. As Carol stated: “It is testing the kids for quick response, like memorization. The kids love it because it's fun.” Think Through Math (TTM) is a software that allows teachers to track students’ learning progress. It is a self-learned software that provides adaptive lesson pathways. As students advance through, they interact with highly focused content purposefully chosen to help students make connections algebraically. It has an embedded virtual teacher in the software to assist learning if students have questions. Students can continue to use this software at home. If students need help, they can log on and talk to the virtual teacher. Students can take notes before taking quizzes. Oprah shared her thoughts on a successful case of using this software:

> Having a student that didn't pass the STAAR the first time, and they only get like two weeks from the time they get the results in order to retest. That student dedicated herself into making sure she did TTM faithfully for 30 minutes to one hour a day. She was successful on the retest.

STEMscopes is a software used in science classes. It is a blended Science, Technology, Engineering, and Mathematics (STEM) learning software. The modules include language arts, reading, and math with the science concepts. Betty commented:

> Because they're continuously practicing their mathematics, they're having to read and understand the vocabulary. They're actually having to hear it. For a lot of our students who don't have that academic language, it helps them be able to see it

> here [in the app] and then also begin to write it and talk about solubility, solutions, and mixtures. We did Kool-Aid and different things that they were familiar with but now they have understanding. This is a solution. What is the mixture? If it goes to the bottom, how do we separate it? How do we get them extracted? Having them problem solve to figure that out will help with [an app] like the STEMscopes.

In addition, participants shared their perceptions of how educational mobile app software could improve students' technology literacy. For examples, Helen integrated the Brain Pop app to improve students' multimedia and internet literacy. Debbie integrated PowerPoint in her classrooms for students to add hyperlinking, sound, and images to improve their presentation literacy. Cynthia shared her thoughts by saying, "I think a lot of fifth graders could improve telecommunication and internet literacy when they start presenting and learning to use PowerPoints and they love that."

Participants across all common core subject areas perceived that educational mobile app software provides ample opportunities to support learning. Betty described: "I call them digital natives. Elementary students were born into technology. They [the students] love technology and will fight to gain access." Teachers were more likely to integrate educational mobile app software that engaged students. As Barbara commented, "The kids like that [Reflex Math] because they're learning, it's engaging and it's also fun for them." She further emphasized this by saying, "We want to make sure it's something that they [students] are engaged in. We need something that's fun so they can be engaged in the lesson."

Rebecca reflected on her perception of the influence of integrating educational mobile app software on students' technology literacy saying:

> Word processing literacy is related to empowered learner because students they come to school to learn. It is an essential skill that they [students] need to learn and use. I can see social and ethical literacy falling under digital citizenship. Multimedia and presentations literacy is with [apps in] global collaborator and creative communicator and with innovative designer [categories]. Spreadsheets literacy is going with [apps in] computational thinker and knowledge constructor categories.

In a focus group interview session with four fifth grade teachers, the importance of integrating educational mobile app software in fifth grade classrooms was intensively discussed among the participants. The consensus among all participants was that pedagogies in secondary schools are transforming from teacher-centered to student-centered learning. Technology literacy is essential for them to be successful. As Jane described:

> We're teaching fifth grade. They're [the students] about to branch out into the next level of school and they're about to be exposed to a lot of more different people, a lot of different situations. It will allow them [the students] to learn how to do the programs like the Word and how to send emails and all that. Because for the ones that don't have a computer at home, they just don't know how to do it. But they have to. They are expected to know when they get to the next level.

In response to Jane's comment, Karen added:

> As they get to middle school or high school, I know there's a lot of times for the flipped classrooms where they have to do all of the technology and work at home then they'll come back and talk about it in the classroom. So they'll need to be able to have that discipline and that that knowledge to keep up with the flipped classroom too.

Virginia agreed and added:

> They [students] need to be exposed to that technology because it just balances the classroom out. We have been trying to incorporate STEMscopes [an educational app] with all STEM related contents. The kids need that. They need to be exposed to that because even though we are lacking technology materials or apps here. They are going to need good apps for the future.

Jane further commented:

> A lot of the jobs of the future haven't even been invented yet. They're not even around yet. They [Students] are going to need all these different apps and things like that. I think it's imperative nowadays. Now it's very important because they're going to need it in order to keep up.

Karen echoed Jane’s thoughts and added:

> It's again that social and ethical issues of you having to be able to think outside of your own little world and write about how you would respond to different scenarios. It is really important especially for once again into that secondary and post-secondary world that they have to learn how to set themselves aside and look outside their world.

Students need the telecommunication and internet literacy to curate resources and information to create artifacts, such as PowerPoint slides and Word documents, for projects or assignments. By integrating educational mobile app software in to classrooms, teachers perceived these literacy skills could be improved. Tina shared her thoughts, stating:

> When I saw innovator designer category, I thought about the multimedia and presentations and also with the telecommunication. You [students] are a creative communicator and maybe global collaborator because you cooperate with others if you do a video conference with the kids you're collaborating with someone in Africa in Kenya. I am thinking with social and ethical issues is related to apps in digital citizens [category].

All participants agreed that technology literacy could be improved by integrating educational mobile app software in classrooms. Oprah emphasized that technology literacy is crucial to the elementary students by stating, “We’re going into a technology based system. It gives them that hands-on opportunity. Those are some of the things that we definitely have to have because that is where we're headed. That’s vital.” In addition, all participants perceived that these educational apps could positively influence students’ technology literacy in seven strands. Among all technology literacy, word processing, multimedia and presentation, and social and ethical literacy were the most commonly commented on technology literacies. The following sections are the emergent themes shared by the participants.

Word processing literacy. This literacy is a prominent skill for the fifth grade students as expressed by most participants. They perceived that educational software

could cultivate word processing literacy and assist students with writing difficulties in improving word processing literacy. For example, Charles expressed his concerns by saying, “Using apps opened up the whole world for kids who don't like to write and the kids who have trouble writing.”

Charles intensively integrates Microsoft Word into instruction. He considered that Word is a software that could greatly improve students’ word processing literacy by stating:

> [Using] Microsoft Word as a writing app not only improves their knowledge about word processing but it helps in their writing approach. I taught them not only to use everything that's inside of Word, such as formatting paragraphs and indentions and all that stuff, but also taught them how to share what they wrote with me. That opened up the whole world for kids who do not like to write or the kids who have trouble writing. I found out that [is] especially [helpful] for my special ed. kids. They love to write. So they put their thoughts down on paper and again we went through the same thing with the same tools that we use with just their handwriting, spelling, capitalization, sentence structure, paragraph structure. We did the same thing but it was on the screen but it was much much easier. So when they send what they wrote to me, I've used a comment section in highlight areas that I think they should focus on, praised them for areas that they did well on, and they see it instantly. So I send it back to them. They correct it and they send it back to me. It is sort of like playing with a ping-pong ball but [using] pages with Word.

Another teacher, Helen, also integrated Word in her teaching. She commented, “Word processing literacy would be like using Word document to help that because when they're typing away and all of a sudden they misspell a word that will kind of revert back and show them that you get a misspelled word. It [Word] will show them.” Students need word processing skills to work on research papers and projects. Debbie considered this literacy essential by saying, “Word processing literacy [could be improved by] using Word for sure because they have to do research and writing papers.”

By integrating Istation in her classrooms, Cynthia perceives that students’ word processing literacy could be improved through this app. She stated:

> Istation could improve word processing. I've watched some of them [using Istation]. Obviously, they read and they have to answer questions depending on where it tracks them. The level that it [Istation] shows up as they progress and there's somewhere, there's actually some typing they have to answer-summarize and answer questions. So there, that's pulling in their word processing [literacy] and it [Istation] is helping with that.

Another district-provided subscription, Learning.com, was commonly integrated in fifth grade classrooms to improve student’s technology literacy. Learning.com is a web-based learning resource. It is a paid subscription that provides online lessons to learn how to understand, use and safely interact with technology, media and digital resources in real-world situations. As the web site describes:

> Children may be able to play video games and use cell phones, but that doesn’t necessarily mean they understand basic uses, best practices, and safety risks when it comes to technology. So, what is digital literacy? It’s the ability to understand,

use and safely interact with technology, media and digital resources in real-world situations.

Teachers integrated Learning.com into their instruction to improve students' technology literacy in many strands. Bill stated, "I think they have something on learning.com that teaches you how to do those things [lessons to develop technology literacies] and but it also teaches you how to type." Debbie commented:

> Also in the computer lab week [students are] doing practice on Learning.com. Well, they have games on there and the kids, you can see on my board, "practice at home". They know how to get on, they know the site, and they know what to go to practice and so, [developing] ethics [literacy] on the computer. So they go on that, they, you know, the thing is they can go to the same one [exercise] and they're hearing it over and over and repetition is important. Yeah, so if they can hear it more than once and if they can hear it in more than one way and make that link, that just makes it stronger. They are more likely to remember.

Rachel reflected, "Learning.com focuses more so on this [developing technology literacies] because it is technology-based. It goes through and shows them two little videos and then they have a quiz to help them with learning about word processing."

Multimedia and presentations literacy. This technology literacy was mentioned frequently by participants. Most participants perceive that it would be suitable for elementary students to develop and master this literacy so students begin to learn how to present especially in fifth grade before they branch into secondary schools. All participants perceived that educational mobile app software could improve multimedia

and presentations literacy. Microsoft PowerPoint is the most commonly used software to develop this literacy.

The multimedia and presentations literacy allows students to demonstrate their creativity and knowledge on any subjects and to present to other students. Virginia described, “They [the students] will have to present for everybody. They will get up there and present. There was no paper or pencils.” Some participants incorporated this literacy in conjunction with other activities. For example, as Charles stated:

> We use the NASA app lots. They take what we have here and they make slideshows. They make movies. It makes some kind of illustration to get their point across and I let them present it into the classroom. I got a hundred percent participation in presentation and all the kids loved it.

As most teachers have been integrating educational software to develop multimedia and presentations literacy, some fifth grade students have mastered this literacy. Debra shared her thoughts on how students illustrated this literacy by commenting:

> Some of them are really good at using them like PowerPoint. These kids can just whip out some of them in the multimedia presentations. I think it will be very useful to them as they get older and move out into a working world. I think it will be useful to them.

Charles integrated Microsoft Sway into instruction as the software for presentations. It allowed students to select the software that they feel comfortable using. He explained:

> I introduced them to PowerPoint and Sway. I told them this is a presentation app you know. We do science alive so this is where you can show me your creativity and also your knowledge of whatever topic we're on. So all throughout the year we've had projects where they do it either in Sway or PowerPoint. They send them to me the same thing. I, you know, make comments send it back. They correct [it and] send it back to me and the finished product, they get to present it to the classroom.

Rebecca integrated Chatterpix software into her reading classroom. This software allows students to use multimedia artifacts, such as recording voice and adding voice to photos. The information from the developer's web site described the use of this software:

> Simply take any photo, draw a line to make a mouth, and record your voice. Then share your Pix with friends and family as silly greetings, playful messages, creative cards, or even fancy book reports. And best of all, it's FREE! AGES: 6-12.

This software could be used to develop students' multimedia and presentations literacy. Rebecca integrated this software to allow students to present their reading comprehension. She shared her thoughts:

> I use Chatterpix. They can use it for a book review to tell what happens in the book, whether or not they enjoyed it, what they learn from it. That will be a type of multimedia [pictures with voices] in a presentation.

This literacy is perceived by all participants as a very important skill to be developed before elementary students branched into the secondary schools. Some participants suggested this literacy could be developed as early as lower elementary

grades. Barbara commented, “Multimedia and presentations could be improved, using, like PowerPoint. I think it's a skill that they should work on early because they're going to have to do it in middle school and high school for presentations.”

Social and ethical literacy. This literacy is the ability to understand internet safety and ethical issues pertaining to communications and interactions online through social media or mobile application software. Most participants considered it as a very important skill for elementary students. Betty even denoted this literacy as a “monumental” skill. SISD provides mandatory tutorials for online social and internet safety. Tutorial materials included videos and PowerPoint slides for internet safety and digital citizenship informational, social media cyber safety lens, and personal internet safety. These materials were available on the SISD district web site. Teachers incorporate them into instruction by showing PowerPoint slides in their classrooms and videos related to digital citizenship once every nine weeks. In addition, all fifth grade students are enrolled on learning.com, which provides additional online lessons to assist students in understanding social and ethical issues.

Many participants expressed their concerns on how students interacted and communicated at schools. In a focus group session, Jane shared her thoughts, describing:

> Some students do not socialize or communicate the same way as adults. Students interact and communicate using software applications. They hide behind their device and social media. They do not have the social graces and they don’t have the communication skills.

Karen echoed Jane’s comments and added:

> They can't even look at you in the eyes. I mean some of our students, [when you] are talking to them [students], and they're just looking wherever else except at you. In our culture, you look at someone when they're talking to you versus they don't get used to that. They're not able to have face-to-face communication. They're hiding behind you.

As students are spending more time online for academic works or personal entertainment, the lack of social and ethical literacy becomes more imminent and important issues to be improved. Cynthia shared her concern, commenting:

> Social and ethical issues, I think that's important. I don't think they understand and get that at this age. They don't see the importance and the dangers as well for the safety part of it and so I think this is something that certainly needs to improve.

Jane had similar concerns as she stated:

> I think that learning social and ethical issues are very important because it's just something that hasn't gotten completely lost. But it's going in that direction [of losing social and ethical literacy or] the like. That's pretty dangerous. I think that it's going to be very detrimental to society and so I think that social and ethical issues are definitely something that need to be taught.

Educational mobile app software specifically designed to address these issues and improve students' social and ethical literacy is scarce in the app markets. Jane expressed her concerns, stating:

> I don't know if [it is] something like an app that could give them situations or something that they can say what would you do in this situation and they may not have even thought. Oh well, then maybe that would hurt somebody.

This type of educational mobile app software could assist students in developing social and ethical awareness and recognizing the rights and responsibilities in a digital world.

In addition to the qualitative data analysis, research question four was answered by analyzing the quantitative data from the survey item 8, *If integrated appropriately, mobile application software could improve learning outcomes*. Twenty-three participants responded with "*Agree*" and forty responded with "*Strongly Agree*" as illustrated in Table 4.15. Findings indicated that 36.5% of participants agreed and 63.5% strongly agreed that educational mobile app software could improve students' learning outcomes if integrated appropriately in classrooms. Table 4.16 illustrated the descriptive statistics of survey item 8.

Table 4.15

Responses of Survey Item 8 (%)

Survey Item 8	Strongly Disagree (%)	Disagree (%)	Agree (%)	Strongly Agree (%)
If integrated appropriately, educational apps could improve learning outcomes (n = 63).	0	0	36.5	63.5

Table 4.16

Descriptive Statistics of Survey Item 8

	n	Mean	Std. Deviation	Variance
If integrated appropriately, educational apps could improve learning outcomes	63	3.62	.49	.24

Research Question Five

Research question five, *What are teachers' decision processes, methods, and criteria to search, identify, classify, and select educational mobile app software?*, was

answered by using an inductive coding process to analyze the data collected from the semi-structured interview questions during the individual interviews and focus groups. The analysis derived three distinct themes including: (a) rubric, (b) methods, and (c) criteria.

Rubric

When participants were asked, "*What is your perception of having a rubric to assist you with finding the appropriate app for your specific instructional needs*?", all participants agreed, some very strongly, that a rubric would be helpful to assist educators in identifying and selecting educational mobile app software. Most participants recognized that a rubric for educators to classify and select educational mobile app software should contain a list of well-defined categories. Categories should be precise and not too broad. The purpose of this mixed methods study was to employ the ISTE standards as a taxonomy to classify educational mobile app software and empirically examine the influence on students' technology literacy. The seven categories of the ISTE standards include empowered learner, digital citizen, knowledge constructor, innovative designer, computational thinker, creative communicator, and global collaborator. Most participants agreed that a taxonomy with these seven categories would be a great rubric to assist educators in classifying and identifying educational software. New teachers, as well as teachers with fewer years of teaching experience, are in the process of trying to identify and select appropriate educational mobile app software to be integrated into their instruction. A rubric could greatly assist them in accomplishing this task. Debra shared her thoughts on having a rubric to assist new teachers, saying:

> I think that would make a huge difference especially to the beginning and new teachers that have only been teaching for a few years. They're trying so hard and they're really struggling looking for something to support what they're trying to teach and it's just not easy to access right now.

There was a growing consensus among the participants that it would be challenging and difficult to find appropriate educational mobile app software from various online app stores based on the way they are organized. Rachel reflected her own experience and frustration on searching for apps at app stores by sharing her thoughts:

> Looking at the iTunes app store, I'm just like, I don't know. This app looks cute. So I'll click on the star and see if that's what I need for my kids to work on or not. If it is not [what you expected,] you are kind of stuck because you just bought an app or you just have this app sitting there. Eventually, what will happen is app stores, companies like Apple, will say, so here's these categories, here's this rubric. People are starting to look for apps that fall in these different categories. They [the app stores] will even take it upon themselves to try to say, here are the recommended apps for empowered learners. I think this would help to narrow it.

Participants in this study perceived that a rubric could assist them in identifying and selecting appropriate educational mobile app software. This finding is congruent with the findings from the quantitative data of this study. In addition to the qualitative analysis, research question five was answered by analyzing the quantitative data from the survey item 6, *A rubric can assist educators in effectively classifying, identifying, evaluating, and selecting educational mobile application software*. Thirty-two participants responded with "*Agree*" and 31 responded with "*Strongly Agree*" as

illustrated in Table 4.17. Findings indicated that 50.8% of participants agreed and 49.2% strongly agreed that a rubric could assist educators in effectively classifying, identifying, evaluating, and selecting educational mobile application software. Table 4.18 illustrated the descriptive statistics of survey item 6.

Table 4.17

Responses of Survey Item 6 (%)

Survey Item 6	Strongly Disagree (%)	Disagree (%)	Agree (%)	Strongly Agree (%)
A rubric can assist educators on effectively classifying, identifying, evaluating, and selecting educational apps (n = 63).	0	0	50.8	49.2

Table 4.18

Descriptive Statistics of Survey Item 6

	n	Mean	Std. Deviation	Variance
A rubric can assist educators in effectively classifying, identifying, evaluating, and selecting educational apps.	63	3.49	.51	.26

Methods

Southeast Independent School District (SISD) provides a list of educational mobile app software that was reviewed and approved by a committee comprised technology learning specialists. It is published on the district main web site for teachers to select and integrate into their classrooms. However, without a rubric to assist them, how do teachers search, identify, and select educational mobile app software from this list to be integrated into instruction? Participants shared their own methods pertaining to

obtaining educational software for classroom use. Two emergent themes of the methods that teachers employed are organized into two categories.

Self-assessment. When participants were asked, "*How did you make the decision to use the apps you picked for this school year?*", the most common method that participants utilized was a self-assessment approach. With this method, teachers spent time themselves on reviewing or playing with educational software that they were interested in using.

Debra shared her approach by saying, "I preview it before I actually use it in the classroom. I pretend like I'm the student and I go through the app." Debbie employed the same self-assess approach to determine if an educational software could be integrated to support her instructional goal. She commented, "I viewed it first because you need to always do that first."

Some participants employed a test drive or pilot test approach to verify if an educational mobile app software would be effective by testing the software on their family members or in a pilot classroom. Tina asked her niece to help by saying, "I use my niece as a guinea pig and have my niece try it." Some participants installed educational software on their own devices at home and had their children try the software.

Test drive or pilot test. Another approach to verifying educational software was to pilot test in classrooms. Charles shared his approach by stating, "I try it in classroom. If they don't seem to like it, then let's try something else." Similarly, Tina employed the same approach in her classroom. She stated:

> When I get to work on Monday, we will do a trial run for a day. I pick a certain class to try it out to see if they like it. I'll show my fifth grader students what I have stumbled across. I start with an app and let the kids try it out.

With this pilot test approach, participants utilized immediate feedback from the testers to determine if an educational software was effective and then could decide to continue or stop using it with criteria to be discussed in the next section. Helen shared her way of gathering responses from students to determine if the app was effective by stating, "I ask students to write feedback on what they learned through the use of the educational software." Charles commented that he observed students' behavior if they like using the educational software. Tina employed a similar approach to gain feedback. She shared her thoughts, saying, "I get feedback on like, what do you like about this app, what was fun about it, what didn't you like. Based on that [the feedback, I decided] to continue the app or discontinue it."

Criteria

Participants employed an array of methods described in the previous section to identify educational mobile app software. To implement these methods, a variety of criteria were employed by participants to determine which educational mobile app software would be integrated into their instruction. When participants were asked, "*What are your criteria or methods to evaluate apps that will meet your educational needs?*", the most commonly shared criteria were *ease of use and user friendliness, accessibility and compatibility, assessment and progress tracking, adequate levels of difficulty,* and price.

Ease of use and user friendliness. The most commonly utilized criteria was ease of use and user friendliness of educational mobile app software. All participants mentioned this criterion as either their number one item or high on their check list to examine if educational software could be considered for integration. If a software is too hard or difficult to move through, teachers are not likely to consider using it in the classroom. Even for students whom teachers deem as digital natives, participants indicated they would not consider integrating the software that did not meet this criterion due to limited instructional time in their classrooms. Helen expressed her concerns from the perspective of low achieving students by commenting:

> Is it going to be something easy and self-explanatory? That would be the first thing to check. Is it very very easy to use? Is it going to be easy to manage and use and help the kid feel successful especially if they are low achievers?

If an educational software is not easy to use then teachers would have to stop and assist in getting students to move though the software. Tina shared her concern, saying, “I would say something like kid-friendly, catch the eyes, something easy to manipulate themselves without me having to stand by them and say, okay, click this and click that.” All participants in a focus group affirmatively agreed when Bill stated that ease of use and user friendly is one of his criteria for considering to integrate an educational software. Similarly, Oprah shared her thoughts by commenting:

> The number one thing is the ease of use. Usually, if it's too complex which means you have too many steps. I like to be able to sign in and actually see the procedure on how to use it and then it's go ahead and be able to use it. I don't want to have to

> try and search and find all over again once I get inside of it. It should be something that's really simple, straight to a point.

Accessibility and compatibility. These two criteria were also frequently used by participants to determine if educational apps could be effective. Accessibility is in regard to how students launch and access educational mobile app software on mobile devices or computers. It is a common practice to require a login for using educational apps. A successful authentication allows user to access their profile and data previously saved either on the device or on the network. Students are assigned either a central login to the district authentication or a separate account for online web resources. Without a centralized authentication, there are multiple accounts for different educational apps for students to remember. This could cause issues, such as being unable to login if students forgot their passwords or class being interrupted while teachers are trying to assist. Bill shared his thoughts on the accessibility, stating:

> They [students] use the same ID number but then the password for this app is this one, the password for another app is another one. It is a big block if there was not an authentication method where kids could just go use it. That would be very important.

Compatibility is the ability to launch an educational software on a variety of devices, such as smartphones, tablets, laptops, or computers. These devices could run on different operation systems (OS), including Android, iOS, Windows, Mac OS, and Google ChromeOS. Software programs that could run across multiple platforms have higher compatibility than the ones that only run on few or, sometimes, only single platform. Helen shared her concerns, stating:

> Is it going to be something that is easy for the kids to log on for themselves rather than me having to constantly monitor to them? Is it going to be easy for them to say “oh yeah, I know my login, I know my username,” Boom [login was successful]. Or, if it's going to have a central login and username just for something to do that's not going to necessarily record their happenings but just rather to be able to get on.

Educational mobile app software designed to be compatible across a variety of platforms could provide better opportunities to extend learning if students can access from their devices or computers at school or at home. Bill emphasized that this was an important criterion for him, commenting:

> It needs to be cross-platform for a phone or tablet, Android, and iPad. Well, it needs to be Mac OS also. I think most of our students if they have something, it is probably a PC because they're cheaper. But if you go across town [to more affluent schools], they're going to say, well, it's all about Mac OS. We can't do [use] it because my mom's got a MacBook Pro or MacBook Air or whatever. Cross-platform is important. That’s hard.

Assessment and progress tracking. Assessment and the ability to track progress is another important criterion for teachers to consider when using educational mobile app software. The emergent themes from participants’ responses indicated the ability to assess students’ comprehension with the software program is important. In addition, the ability to keep track of how students are doing and their progress could provide valuable information for teachers to understand how each student is learning.

Istation and iReady are two software programs frequently mentioned by participants that provide the ability to assess students' learning and keep track of learning progress. Debra shared her experiences of using iReady, saying, "With iReady, I can look at their data online also to see where they've made mistakes and where they need additional assistance." Rachel integrated Istation to assess students' learning. She stated:

> Like Istation. It tracks them. The results of the assessment, you can see the students that struggles with one thing. As they're working on it, you can see it's different from this student that doesn't struggle with it. I noticed for the kids if it's colorful there's like a little bit of music or something. If it's a game built into it they really seem to enjoy that.

Adequate levels of difficulty. The ability to guide students through adequate levels of difficulty was also a common criterion utilized by participants. Apps designed with this feature could automatically adjust the levels of difficulty of content and assessments based on students' skills or knowledge levels. An educational software that provides different levels of difficulty are considered to be a great software to be integrated. Barbara stated:

> Some of those [apps] were not too challenging. We want to make sure that it is challenging and testing their comprehension. We want to make sure it is something that they are engaged in and we want to make sure it is something where we can track their data. We want it to be challenging, of course, but not where it's too difficult for them to even complete it.

Helen employed this criterion when looking for educational software that could meet her instructional needs for both students with higher achievement and with learning difficulties. She shared her thoughts by commenting:

> I would look at it also in the terms of every other level but mostly I would look at it from my lower achievers because sometimes they may not get the lesson. They like pressing buttons. They like looking at things on this screen. They [Students] like sound. Is it going to be something that will make them feel successful? And then to even go to the opposite end, if you have a GT student, it allows them to go into a deeper thinking.

Not all educational mobile app software programs were created equal. Some educational apps were designed specifically to support instruction, such as Istation. Some were designed to reinforce and retain information, like Reflex Math. Consequently, there were some educational software that were designed without any learning components, such as BrainPop. This type of educational app served as an entertaining or reward type of purpose. However, most of the participants preferred to integrate educational mobile app software that could better accelerate advanced students. They perceived that students need educational software that could augment and propel those who have mastered the intended skills. Oprah shared her thoughts on how she determined to integrate the Think Through Math (TTM) and Khan Academy, an online resource for K-12 learning, in her classrooms, stating:

> Khan Academy, we use it for accelerated students just to push them beyond where they are. Think Through Math is good to help get you on level and make sure you

> catch up with anyone else. Khan Academy was more for the accelerated to try and push them.

In addition to the TTM and Khan Academy, Istation also provides a feature to differentiate the learners with levels. Bill strongly recommended these programs by sharing:

> Like Istation, how it's leveled or it scaffolds, Same thing with Think Through Math. Those programs that are developed with intelligent design. It's a smart differentiation program that routes the student to different courses and it predicts what they need to work on. Those types of software are some of the most powerful ones. When you get into the really powerful stuff like Istation or Think Through Math and there's more stuff out there that we don't use, those things that differentiate and scaffold and put you where you need to go. Those really have a big impact.

Other criteria. There were a few other criteria that were shared by participants during the interview and focus group sessions but were not as commonly employed as the ones discussed above. Teachers selected and integrated these educational mobile app software programs for a myriad of purposes, such as rewarding and engaging students. For example, teachers might need to integrate certain educational software for a reward type of purpose to manage students' behaviors. These educational apps are mostly fun and game-based software. They could be used to keep students engaged, keep them on task, quiet, or just to jazz up the instruction as Helen shared her experience, saying:

> It's just an extra added resource if I wanted to use it. Like today for example, we had just explored the NASA and so I was like, okay, we did enough math for

> today. I'm going to use the BrainPop to explore more on the space. I use that [the BrainPop] a lot. We played a movie and then we took a quiz okay on it. So [as a teacher,] you see as necessary or appropriate based on the time. It's something different to jazz things up a bit. It's not like you go to that continually.

Another frequently mentioned criterion was the pricing of educational mobile app software. Most participants responded that they prefer to select apps that are free of charge. It is largely because of the limited district or campus funding for purchasing software. Depending on the number of devices, it could cost sixty dollars for a $1.99 app on a typical iPad cart that is equipped with 30 iPads. Most teachers indicated they prefer to integrate district-approved educational mobile app software simply because of this reason even if the apps might not meet their instructional needs. In some cases, the district requires teachers to mandatorily integrate educational software that had been purchased to justify the cost of subscriptions. This could potentially reduce the effectiveness and influence of integrating educational mobile app software on students' learning outcomes.

Research Question Six

Research question six, *What are teachers' perceptions regarding the ease of obtaining and integrating educational mobile app software?*, was answered by using an inductive coding process to analyze the data collected from the semi-structured interview protocol questions during the individual interviews and focus groups. Participants were asked what resources, challenges, and barriers pertaining to integration of educational apps into instruction in classrooms existed. Findings from the responses of participants indicated there were several prominent challenges and barriers that impeded the fidelity

of educational mobile app software integration in classrooms. The most commonly discussed issues were described with sample comments from participants concerning: (a) lack of time, (b) lack of resources and educational mobile app software, and (c) lack of training and support.

Lack of Time

The time crunch in teaching was the most commonly expressed concern shared by all participants across the multiple schools studied. A lack of instructional time had a tremendously negative influence on how teachers integrated software into their teaching. It was predominately caused by classroom scheduling, curricula and instruction, and administrative works, such as grading, parent conferences, meetings, and Professional Learning Community (PLC). There were several reasons shared by participants that could contribute to the time crunch in teaching as described in the following sections.

Classroom scheduling was one of the biggest reasons for teachers' lack of time. All participants were part of a two- or three-way split as their scheduling. An example of a three-way split is where one teacher teaches science and writing, another teaches social studies and reading, and another teaches mathematics or geography. Each block is approximately 90 minutes. As Karen shared in a focus group, "So you want me to do all these [instructional units and TEKS curriculum] in 90 minutes? It's hard.". Carol, from a different school, also had a similar comment as she stated, "I don't have the time in the day because the three of us are in a three-way split. We rotate three times a day."

Helen, a veteran teacher who used to teach in self-contained classes, perceived that block scheduling would make it more difficult for teachers to integrate educational software into instruction. She shared her experiences, saying, "I found that having a

three-way split, it just didn't leave me enough room to explore different varieties [of instructional time arrangement] to use technology." She later added, "You do not have time even when you have self-contained [classes]. You still have structured time but you can rearrange it still whereas blocks, you can't. It's still centered around time."

The prominent reason that caused the time crunch in teaching was the class scheduling. With block scheduling in which teachers taught and rotated classes multiple time a day, it would be more difficult to rearrange instruction time for students to spend time on using educational software. While with self-contained scheduling, teachers can move instructional units to make time for technology integration. There were other reasons also attributed to a time crunch in teaching shared by the participants.

The second theme that caused a lack of time in teaching was related to the state and district curriculum and instruction plans. s These plans were developed and published by the district as curriculum pacing guides. They played a crucial role in how teachers arrange instructional time and, consequently, influence how they integrate educational mobile app software in classrooms.

Southeast Independent School District (SISD) published a calendar with curriculum pacing guides for all four grading periods in a school year. These nine week pacing guides encompass the instructional units and TEKS to be incorporated. Teachers meet and collaborate with administrators during structured grade level professional learning communities (PLCs) during teachers agreed upon time. Teachers will be held accountable for effectively implementing the curriculum using technology, assessment data, and research based instructional strategies. Consequently, teachers have to put some

activities aside to complete their instructional units. Debbie, who had been teaching for 19 years, expressed her concern by sharing:

> We have curriculum. We have to teach a curriculum schedule. Here's my schedule. What date I have to do what units and we have to keep going. Because it takes time. That's the biggest thing. I wouldn't mind having another hour of class time for kids to really be able to teach.

In a focus group with five teachers, there was a growing consensus that the district's curriculum plans required teachers to spend all of their "precious" classroom time to cover instructional units. That could hinder the availability to integrate educational mobile app software in their classrooms. Karen expressed her concern by stating:

> We have our sequences where you've got fourteen days. You've got ten days. If you go over, they [next units] need to start, you encroach on the next unit that you need to be on. So there's very little time to put in that [use of educational mobile app software].

In addition to classroom scheduling and curricula, other teaching and administrative tasks, such as grading, meetings, and PLCs, also attributed to the time crunch in teaching. SISD requires teachers to submit grades with a certain period of time. Most teachers have to complete these administrative tasks either after school on their own personal time. Debbie shared her experiences by saying:

> I don't grade during my instructional time. My kids have no down time in my class. There's always something that they are doing. I have to walk around and supervise and see if they're getting it and all that. So, I can't do it during school for

> the most part. I have to do it after school. I'm here at a quarter to seven and I'm here till 6:30 at night to get everything in.

She perceived this has been a big issue to all other teachers at her campus. She added additional comments to express her concern:

> At least at my campus, we have to do this, that, and other things besides doing what the curriculum is asking. In my perspective, most of my friends [teachers] around here, they will say the same thing. They [district and campus administrators] keep putting more and more things that we have to do within the same amount of time. Because we have to do this, we have to do that. These little things that we have to throw in there that chops up our time. That's a big big issue.

Classroom scheduling, curriculum and instruction, and non-teaching tasks were the most commonly expressed concerns that could negatively influence how teachers integrated educational mobile app software into instruction. When instructional time is limited, teachers preeminently focus on completing the priorities before considering use of technology. As Helen commented, "Because it's a time crunch and I had to stick with the district's curriculum plan. It left me little to no room to use other resources other than quick hands on [using educational software for a few minutes]." In addition, there was a growing consensus in a focus group as Karen stated:

> We have so many things and we have certain objectives that we have to cover. It's a time frame. We are just given too much on our plate to do and this kind of things [developing students' technology literacy by integrating educational

software] just sits on the back burner. You hit it [improve the technology literacy in seven strands] as much as you can.

Participants perceived that lack of time in teaching was primarily caused by classroom scheduling, curriculum and instruction, and non-teaching tasks. When time is in an essence, teachers would not consider integration of educational mobile app software as a priority. Teachers would try to integrate software into instruction only if there was time to do so. This barrier could hinder the fidelity and effectiveness of educational mobile app integration.

Lack of Resources and Educational Mobile App Software

A variety of resources provided the list of available educational mobile app software for teachers to select and integrate into their instruction. The most common resources were campuses librarians, subject matter experts and specialists, mentors, coaches, and PLC. These resources were located at their campuses where teachers have direct and convenient access to them.

Librarians played a crucial role in providing information and assistance to teachers pertaining to educational software. They were most commonly utilized resources at the campus level where teachers obtained the information and a list of available educational mobile app software. Another reason that teachers went to librarians was to get assistance and support. Part of the librarian's job responsibilities was to serve as instructional specialist and provide in-service training for teachers. One of the librarian's duties was to manage and secure campus technology equipment, such as iPad carts and laptops. For example, an elementary librarian would need to assist teachers by providing

a list of district-approved educational mobile app software and installing approved educational software on devices or computers.

At SISD, teachers do not have permission or access to install educational apps. They have to go to their campus librarian and go through a process to get apps they need. Carol shared her experience, saying, “We can't download it, it has to go through our librarian and she has to take care of it.” Charles, from a different school, also had the same experience. He stated, “I give the name of apps to the librarian. She writes out this trouble ticket to request them to be added to the iPads.”

Subject matter experts and specialists are also common resources where teachers could seek advice. For example, Helen commented that she constantly checked with all these resources at campus to get information. She stated:

> We have a librarian. She provides us a little introduction of how they rearranged the media services resources. She's usually one that I will go to and say, what would be a good math application that I could use? Another one would be the math specialist. She's the one that told us the Reflex Math as well as the Think Through Math that we use. And then every so often, I will check with my team leader and say, “how do you use so and so"?

Based on the responses from participants, all of them predominately used the educational mobile app software purchased by the district. The main reason was that these apps were purchased, approved, and already loaded on iPads or computers. As discussed in research question four, the most commonly used educational mobile app software, such as BrainPOP, Istation, Learning.com, Microsoft Office Suite®, Reflex

Math, Think Through Math (TTM), and STEMscopes, were all purchased and loaded by district.

The Digital Learning department at SISD also played a crucial role in supporting and providing additional resources pertaining to technology and educational software. A committee, comprised educational technology specialists from the Digital Learning department at SISD, constantly reviews and compiles a list of approved educational mobile app software to be integrated into instruction. The list of software is published under the teacher resources area on the district web site. A team of digital learning specialists, who are specialized in technology integration, provide assistance and resources to teachers at the designated campuses. In addition, the district also provides a list of digital media library on the district web site.

Some participants mentioned that the yearly digital learning conference was another resource from which to obtain information. These educational conferences provide a myriad of sessions and workshops with in-depth and hands-on experiences for teachers who were in need of additional resources of educational software. Carol shared her experience in a focus group, saying “I feel like I'm getting a lot of new apps from our librarian, and also yearly the district hosts the digital conference. I've attended that one year and I've got a lot of apps from it.”

However, some of these conferences were only held during the summer breaks and not all teachers could get to attend these conferences. Even with these resources available at the campus and district levels, findings also indicated some participants perceived there was still a lack of available educational mobile app software that could meet their instructional needs. They sought additional information from external

resources. Findings indicated that searching online was the most commonly used method to find additional resources. Teachers could get online and search on Google, blogs, and social media. As Debra shared her own experience, she stated, “I literally go to Google and search ’app’. I think most people search for them themselves. That's what I do.” Rebecca used Facebook and followed other users as a resource to gather information on educational software based on the reviews and feedback from other educators.

A few participants obtained additional information for educational apps by using educational organizations as resources, such as Region 4 Educational Service Center. Region 4 Education Service Center is one of 20 regional education service centers established by the Texas Legislature. It serves a seven-county area comprised 49 public school districts and 38 open-enrollment charter schools, representing more than 1.1 million students, 94,000 educators, and 1,500 campuses (Region 4 Education Service Center, 2017). Region 4 Education Service Center hosts conferences, professional development sessions, and online courses. For example, the Region 4 conference is a two-day event hosted at the main office in Houston, Texas. Participants learn program updates and research-based strategies to enhance learning and gather information related to best practices and instructional techniques in break-out sessions. Region 4 provides professional development sessions throughout the year at multiple locations across the region. A user with an account could access additional professional development resources online available on the Region 4 web site. A few participants indicated this was where they obtained information regarding the educational software they used. Debbie found this resource from a conference useful, saying:

> I can go on to Region 4 [web site] for some training. I've gotten on the different things [training materials] for science. I've been to the conference and they [trainers] gave us hard copies. I'm saving my hard copies so I can go back and read it.

An issue was caused by a lack of resources and educational mobile app software. Many participants raised the same concern on having limited resources and educational software. Students could get bored by using the same educational software over and over again. They became uninterested and disengaged. Teachers described how some students could sit there for minutes without interacting with the software. Or, some students might become a “clicker” and just keep clicking on something without even reading or following the instructions. Jane stated:

> We definitely need more software. There is very limited [software]. We have very few programs on the iPads. They have very few things loaded on there and if you want to load you're not allowed to load anything on there. You have to have approval. By the time [the software] got approval, the school year’s over. By the time they load it, there's a newer version out there and it just doesn't keep up. The ones they have on there. They're okay, but the kids are so used to the same thing. They need to be kept engaged. So some of the ones that they have on there, they're not so flashy and so bright as what they're used to. So they don't like them anyway. We like to go online and we look for stuff. We find stuff we like, say, this is really cool but then you can't use it.

Another area of concern pertained to the process of requesting educational mobile app software that is not provided by the district. If teachers have a need to integrate

educational software that they perceive beneficial to improve students' learning outcome, they would have to go through a process to request and district needs to review and approve it. The process could take a long time to complete. Debbie went through this process and shared:

> We can make recommendations but they're so backlogged then you have to wait. You have to get approval then you have to wait for them to have a ticket to come out and download everything for you because we can't do it. There's a process for everything.

In a focus group session, Bill shared his similar experience, stating, "It would be great if we were more able to readily find things we like and implement them. I know that when it comes to using the iPads, we can't get anything installed on the iPad without 20 different people agreeing and okaying it." Karen agreed and echoed his comments, adding:

> If you get the iPads, there's a couple of preloaded apps but if you find something you want, it'll take you like nine months to a year to get approved (all participants agreed with her) and then another six months to get it installed. So there's not reacting quick enough to the need.

As discussed in the previous section, teachers did not have much time to research and evaluate educational software that could meet their instructional needs. There was a growing consensus on how educational software could be controlled and managed from teachers' perspectives. However, some teachers had varied perspectives and preferred to leave the decision-making at the district level. Virginia commented:

> I would prefer the district to provide the software to us. Because I know they're safe. The accountability is there. They are kid-friendly. I can tell parents that these are good websites to go, the district approved ones, go on to the district web site and they know where to find the elementary resources. Because a lot of these things have to have licenses. You have to have permission just to download it. Or you to have access to it. If the district takes care of all that and they pay the rights for it and we are covered.

Participants perceived that lack of resources and educational mobile app software was an imminent barrier. There was a variety of resources available provided by the district. However, there was a need for more resources and educational mobile app software for teachers to select.

Lack of Training and Support

Findings from participants' responses indicated some barriers and challenges existed related to integration of educational software from teachers' perspectives. Training and support were two areas in which participants also expressed many concerns pertaining to integration of educational mobile app software in their classrooms. A lack of adequate training was a common concern expressed by most participants. To effectively integrate educational software for learning, teachers needed to be properly trained on how to use and troubleshoot them. The district provides some training opportunities, but teachers perceived that this is an area of concern. Professional development (PD) could provide opportunities for teachers to improve pedagogical and technological knowledge. Most of the PD sessions were offered in the summer. However,

teachers would not use educational software in their classrooms until the school started or even later in the school year. As Debbie commented:

> If you do not use it real often, you're going to not remember how to do it and then you just go say it's not worth it. Because it's a matter of time and remembering how to do. If I go to a summer PD and they do not give me a hand out on the steps, by the time I go to want to use something like that, I don't remember how.

Tina expressed her concern on having training sessions available only in the summer time could be a barrier for teachers to learn educational software and how to integrate. She commented:

> I would love to see more trainings. Just showing or introducing the app [how it works and] showing what is it [the app] used for. I'm wishing that some of those training sessions that they offer at the conference could be offered like either somewhere else or some other time.

Consequently, new teachers and teachers who are not familiar with particular educational software found it frustrated and difficult to integrate them. They may come across these unfamiliar educational software from other colleagues or subject matter experts but have never used them before. Without proper training, they would have to learn and figure it out. SME's could offer some training opportunities and resources in PLCs which are generally held after school hours. However, there are some after school administrative tasks, such as meetings, grading, and tutorials, that could prevent teachers from attending these professional development opportunities. As Debra shared:

> I couldn't figure out how to get it [educational software]. It took me quite a while to figure out how to navigate that particular site. I'm better at it now than I used to

> be but I’m sure there is still growth that I can make. I need more support. I can use professional development. I don't think you can take too much professional development but that's just me. That [finding and integrating software] is challenging and difficult and I think [that] I need more [training]. I spent so much time in here [classroom] with my kids that I don't get out to the professional development things. For me, that's something I would benefit from.

Additionally, there were some other barriers also discussed by participants. Underlying technological components, including mobile devices, workstations, Wi-Fi, internet, and user authentications, were crucial to support the use of educational software in classrooms, For example, Wi-Fi or internet may not work 100% during the instructional time in classrooms. Many educational apps reply on Wi-Fi and internet connections to connect to services for authenticating users, accessing students’ profiles, and tracking data. Karen expressed her concerns sharing:

> To actually have Wi-Fi that can handle everything because those rare occasions that we get the laptop but not everyone can sign in at the same time because then it overloads the Wi-Fi. We had a huge problem with that.”

In addition, dropping network connections could be frustrated for teachers and students while trying to use the educational software. Debbie shared her unpleasant experience:

> Our Wi-Fi goes in and out. They [Information Technology support technicians] have just updated [equipment in] our building but it's still dropped the connections and that can be very frustrating. On next Monday, our kids will be taking the TLA test and we have to use the laptops for that. We are worried about

> it being dropped but we are not allowed to use the computer lab because the lower grades have not had the opportunity to go in there for the last six weeks.

Quality and availability of mobile devices and computers in classrooms was also a common concern. Some participants indicated computers do not function properly in classrooms. It could take a while for the technology support to come out and assist. This could greatly influence the effectiveness of educational mobile app software integration in classrooms. The quality and availability of computers was a growing concern in a focus group. Jane shared her experiences:

> One out of four computers is not working. I have three of those newer ones [models] and I have one of those older one that is not working and just sitting there. I have my teacher laptop and that is all I have. Then occasionally we have the iPads come in and the kids are always really happy for that but we only have one cart for the whole school.

In addition to the qualitative analysis, research question six was answered by analyzing the quantitative data from the survey item 7, *It could be challenging to find and evaluate mobile application software for your instructional needs*. Ten participants responded with *Disagree*, 27 responded with "*Agree"*, and 26 responded with "*Strongly Agree"* as illustrated in Table 4.19. Findings indicated that 15.8% of participants *"Disagreed"*, 42.9% *"Agreed"*, and 41.3% "*Strongly Agreed"* that it could be challenging to find and evaluate mobile application software for your instructional needs. Table 4.20 illustrated the descriptive statistics of survey item 7.

Table 4.19

Responses of Survey Item 7 (%)

Survey Item	Strongly Disagree (%)	Disagree (%)	Agree (%)	Strongly Agree (%)
It could be challenging to find and evaluate mobile application software for your instructional needs (n = 63).	0	15.8	42.9	41.3

Table 4.20

Descriptive Statistics of Survey Item 7

	n	Mean	Std. Deviation	Variance
It could be challenging to find and evaluate mobile application software for your instructional needs.	63	3.28	.71	.51

Summary of Findings

This mixed method design study incorporated both quantitative and qualitative data collected from a purposeful sample of fifth grade core subject teachers by administering an online survey and conducting semi-structured interviews and focus groups. Sixteen fifth grade core subject teachers participated in semi-structured interviews and focus groups. Findings indicated there existed some challenges and barriers that impeded integration of educational mobile app software into instruction in classrooms. To improve the effectiveness of technology integration in the educational context, these concerns need to be addressed and resolved. The TLA test was administered to all fifth grade students to assess their technology literacy. Pearson's Product Moment Correlations (r) were used to determine whether a relationship existed between some of the students' technology literacy in seven strands and categorical

choices of educational apps in seven categories. The mean values were used to determine which categories of educational mobile app software in which teachers used more frequently.

Findings indicated there were statistically significant correlations between seven technology literacy scores and seven categorical choices of educational mobile app software at 19 Title I elementary schools. Database literacy scores were reflective of integrating educational software in empowered learner and global collaborator categories. Multimedia and presentations literacy scores were reflective of integrating educational software in empowered learner and knowledge constructor categories. Social and ethical literacy scores were reflective of integrating educational software in knowledge constructor category. Spreadsheets literacy scores were reflective of integrating educational software in knowledge constructor and computational thinker categories. Telecommunication and internet literacy scores were reflective of integrating educational software in empowered learner and knowledge constructor categories. Word processing literacy scores were reflective of integrating educational software in knowledge constructor, innovative designer, and computational thinker categories. However, systems and fundamentals literacy scores were not reflective of integrating educational software in any categories.

Findings from the quantitative data analysis indicated there was not a statistically significant relationship between overall school TLA scores and average frequency of use of educational mobile app software. Higher frequency of use of educational mobile app software in classrooms did not attribute to higher overall school TLA. The average frequency of use of educational app was “2-4 a month” in classrooms at 19 Title I

elementary schools. The mean value of categories of educational apps used in classrooms indicated teachers predominately integrated educational mobile app software in knowledge constructor and computational thinker categories. Consequently, very few educational software in digital citizen and global collaborator was integrated during the 2016-2017 school year.

In concert with findings from the quantitative data analysis, all teachers who participated in the semi-structured interviews and focus group perceived a positive influence on students' technology literacy when integrating educational mobile app software. A myriad of educational software was discussed and shared by participants. Teachers perceived that word processing, multimedia and presentations, and social and ethical literacy could be positively improved by integrating educational software.

Also congruent with findings from the quantitative data analysis in this study, teachers who participated in interviews agreed that a rubric could assist them to find appropriate educational software to improve students' technology literacy. Teachers employed an array of different methods to search, identify, and select educational software that met their instructional needs. In addition, criteria commonly utilized by participants were also discussed.

There existed many challenges and barriers that could impede the effectiveness of educational software integration in classrooms. A lack of time in both teaching and planning was the most prominent factor. Teachers also expressed concerns pertaining to resources and availability of educational software. Training and support played a crucial role in the effectiveness and fidelity of integrating educational mobile app software in classrooms at 19 Title I elementary schools.

Conclusion

This chapter presents the results of the quantitative and qualitative data analysis for this mixed methods study. There were 63 fifth grade teachers participated in the online survey and 16 participated in a semi-structured interview or focus group. Research questions one and two were answered by using Pearson's Product Moment Correlations (r) to analyze data collected through the online survey and TLA test. Research question three was answered by using the mean values to determine teachers' preferable categories of educational mobile app software. Research questions four through six were answered by using an inductive coding process to analyze the data collected from interviews and focus groups. A brief summary of findings is also presented in this chapter. The summary, implications, and recommendations of this mixed methods study are discussed in the next chapter.

CHAPTER V

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

The purpose of this mixed methods study was to employ the ISTE standards as a taxonomy to classify educational mobile app software and empirically examine the influence on students' technology literacy. A purposeful sample of fifth grade core subject teachers at 19 Title I elementary schools were solicited to participate in this study. A total of sixty-three fifth grade teachers responded to the online survey and sixteen participated in the follow-up semi-structured interviews and focus groups. The TechLiteracy Assessment (TLA) was administered to all fifth grade students to assess students' technology literacy in seven strands. This chapter presents a summary of key research findings, the implications of these findings, and recommendations for future research.

Summary

Educational mobile app software is defined as software programs developed to run on multiple platforms, such as iPads, tablets, smartphones, laptops, and/or hand-held gadgets to perform specific functions in the educational context (Cherner, Dix, & Lee, 2014). Hutchison, Beschorner, and Schmidt-Crawford (2012) concluded students must become proficient in the new literacies of 21st century technologies to become fully literate in today's world. The authors asserted educational technologies, such as iPad and educational mobile app software, could provide ample opportunities to foster technology

literacy and means for students to communicate and socialize, and support student-centered and lifelong learning.

Technology literacy is defined as the ability to effectively use technologies, such as computers, laptops, mobile devices, and software, to accomplish required learning tasks (Davies, 2011). Ananiadou and Claro (2009) referred to it as the ability to perform tasks and solve problems in domains, such as information, communication, ethics and social impact. Technology literacy includes skills, such as accessing, evaluating, and organizing information, researching, problem solving, collaborating, socializing, and communicating. Another similar term is digital literacy, which encompasses the skills to share, collaborate, search, analyze, evaluate, and present (Jara, et al., 2015).

The purpose of this study was to classify educational mobile app software and empirically examine the influence on students' technology literacy. There were a total of 85 fifth grade core subject teachers, who worked at 19 Title I elementary schools in the participating school district during the 2016-2017 academic school year and who qualified to participate in this study. Of those, 63 teachers completed the online survey (74.1% response rate). Sixteen core subject teachers (14 females and two males) participated in a semi-structured interview or focus group session. They were from six different Title I elementary schools.

This mixed methods study incorporated both quantitative and qualitative data. The quantitative data were collected from the core subject teachers who participated in the online survey to determine whether a relationship existed between students' technology literacy in seven strands assessed by the TLA and educational mobile app software in seven categories classified by the ISTE standards (see Figure 2.1). The

quantitative data were analyzed using means and Pearson's Product Moment Correlations (r) in IBM SPSS. The qualitative data were collected from fifth grade teachers who participated in follow-up interviews and focus groups by digitally recording all responses and transcribing verbatim. The qualitative data were analyzed using an inductive coding process in QSR NVivo.

Findings indicated higher TLA scores in specific technology literacy were reflective of integrating educational mobile app software in certain categories. These findings are in agreement with the assertion that educational technologies could provide opportunities to develop 21st century skills and foster student-centered learning (Castek & Beach, 2013). Chiong and Shuler (2010) asserted well-designed educational mobile app software could foster learning and promote literacy skills. In a meta-analysis, Fabian, Topping, and Barron (2016) reviewed 60 published papers related to the effects of using off-the-shelf educational mobile app software. Findings supported that students' attitudes toward the use of educational technologies and achievement were interlinked. Findings in this present study also echoed the assentation that use of educational mobile app software changed the dynamics and improved social relations and collaboration (Sessions, Kang, & Womack, 2016). In addition, Eyyam, Ramadan, and Hüseyin (2014) concurred that technology use in class could positively improve students' academic achievement.

Findings in this present study are in agreement with other studies. A body of literature suggested that students' learning outcomes could be positively improved by integrating educational technologies as supplements to teachers' instruction (Sessions, et al., 2016). In a meta-analysis, Hwang and Wu (2014) concluded that mobile learning could improve students' interests, motivations, and learning achievements. Furthermore,

Fabian, et al. (2016) concluded a majority of the reviewed articles reported positive results on students' attitudes and achievement with the integration of mobile technologies.

Participants in this study perceived a positive influence of integrating educational mobile app software on students' technology literacy. This finding is congruent with the results of national interviews with PK-12 teachers (Public Broadcasting Service, 2013). The results demonstrated that approximately 75 percent of the K-12 teachers recognized the benefits of integrating technology and 74 percent indicated educational technologies enabled the reinforcement and expansion on content and motivated students to learn. More importantly, 75 percent of the participants expressed a need for more classroom technology, especially in low-income schools. In addition, Waters, Kenna, and Bruce (2016) found that teachers perceived the use of educational mobile app software as a valuable instructional resource to foster engagement and meaningful learning.

Interestingly, findings in this study indicated there was not a correlation between the frequency of use of educational mobile app software in any categories and students' technology literacy. Integrating educational mobile app software more frequently in classrooms did not result in higher overall school TLA scores at 19 Title I elementary schools. At the schools studied, teachers predominately integrated educational mobile app software in certain categories. The most frequently integrated educational software was in the knowledge constructor and the computational thinker categories. Consequently, educational software in the digital citizen and the global collaborator categories was least frequently integrated.

Finally, participants perceived that it could be challenging and difficult to evaluate and select appropriate educational mobile app software. Participants employed an array of methods and criteria to find, identify, evaluate, and select educational mobile app software to be integrated into their classrooms. Self-assessment and pilot test were the most commonly used methods to evaluate educational mobile app software. Participants utilized a myriad of criteria, such as ease of use and compatibility, to determine if educational mobile app software could be useful learning tools. There were many barriers and challenges shared by participants during the interviews. A lack of time, resources, training, and support were prominent barriers that could impede the effectiveness of educational mobile app software integration. The following sections present the discussions of findings and emergent themes in this study.

Research Question One

To answer research question one, *Are higher TLA scores reflective of the categorical choices of educational mobile app software used in the classrooms at 19 Title I elementary schools?,* a Pearson's Product Moment Correlation (r) was used to examine whether a relationship existed between students' technology literacy scores and the categories of educational mobile app software. Educational mobile app software was classified by the ISTE Standards for Students into seven categories: (a) empowered learner, (b) digital citizen, (c) knowledge constructor, (d) innovative designer, (e) computational thinker, (f) creative communicator, and (g) global collaborator. Participants of the online survey were asked to provide the names and categories of the educational mobile app software that they used in their classrooms during the 2016-2017 school year. Student's technology literacy scores were measured by the web-based

TechLiteracy Assessment (TLA) in seven strands: (a) database, (b) multimedia and presentations, (c) social and ethical, (d) spreadsheets, (e) systems and fundamentals, (f) telecommunication and internet, and (g) word processing.

Findings indicated that database literacy scores were reflective of integrating educational mobile app software in the computational thinker category. Multimedia and presentations literacy scores were reflective of integrating software in the knowledge constructor category. Social and ethical literacy scores were reflective of integrating software in the knowledge constructor category. Spreadsheets literacy scores were reflective of integrating software in the knowledge constructor and the computational thinker categories. Systems and fundamentals literacy scores were reflective of integrating software in the computational thinker category. Telecommunication and internet literacy scores were reflective of integrating software in the knowledge constructor and the creative communicator categories. Word processing literacy scores were reflective of integrating software in the knowledge constructor and the computational thinker categories.

From a different perspective, findings in this study suggested educational mobile app software in the knowledge constructor category could positively influence students' technology literacy in multimedia and presentations, social and ethical, spreadsheets, telecommunication and internet, and word processing strands. Educational mobile app software in the computational thinker category could positively influence students' technology literacy in database, spreadsheets, system and fundamentals, and word processing strands. Among all seven categories, educational mobile app software in the

knowledge constructor and the computational thinker categories were the most preponderant and influential software.

Findings in this study are congruent with the conclusion in a meta-analysis study by Hsin, Li, and Tasi (2014). The authors found a majority of the reviewed studies suggested technologies could support and positively influence children's social development in their ability to collaboratively achieve a common goal. It was concluded technologies could foster social skills for young children. Additionally, young children were able to use multimodal cues, such as pictures, sounds, and gestures, and search information online using Google search engine or YouTube. Murray and Olcese (2011) concurred that some educational software could be used to create multimodal experiences, and to share files or documents using the cloud, emails, or social networking services to collaborate in a social context. In addition, findings are in agreement with the suggestion that educational mobile app software could provide opportunities to foster technology literacy and means for students to communicate, socialize, and support student-centered and lifelong learning (Hutchison, et al., 2012). Findings in this study also echoed the conclusion that students' technology literacy could be positively improved by integrating educational technologies to augment teachers' instruction (Sessions, et al., 2016).

Research Question Two

To answer research question two, *Is there a statistically significant relationship between overall school TLA scores and average frequency of use of educational mobile app software at 19 Title I elementary schools?,* the mean value and a Pearson's Product Moment Correlation (r) were used to examine the correlation between overall TLA scores

and frequency of use of educational mobile app software in classrooms. On average, teachers used educational apps between “once a week” and “2-4 times a month” in their classrooms. The average school TLA score was 225.4. Findings indicated there was not a statistically significant relationship between overall school TLA scores and average frequency of use of educational mobile app software. The frequency of educational mobile app software use in classrooms did not necessarily attribute to higher overall school TLA scores at the 19 Title I elementary schools.

There are very few known studies that investigated the frequency of use and its influence on students’ learning achievement. Domingo and Garganté (2016) suggested the higher frequency of educational software used, the higher impact on students’ achievement through content and skill learning. Findings in this study are in disagreement with this suggestion. The discrepancy could be related to the differences in the populations and instruments. Domingo and Garganté (2016) administered a 5-point Likert scale survey to 102 teachers at 12 public schools while this study used a 4-point Likert scale survey to collect data from 63 fifth grade common core subject teachers at 19 Title I elementary schools.

Research Question Three

To answer research question three, *Are teachers predominately or preferably using educational mobile app software in certain categories?*, the mean value was used to determine which categories of educational mobile app software teachers integrated more frequently. Findings indicated that teachers predominately integrated educational mobile app software in the knowledge constructor and the computational thinker categories. Educational mobile app software in the innovative designer, the empowered

learner, and the creative communicator categories was modestly integrated. Educational mobile app software in the digital citizen and the global collaborator was not frequently integrated.

There is very little known literature that investigated predominant categories of educational mobile app software integrated in classrooms. Findings in this study echoed the results from another study. Domingo and Garganté (2016) investigated the use of educational apps in classrooms. The authors employed a taxonomy that comprised three categories: learning skills tools, informational management tools, and content learning tools. Results illustrated that teachers integrated more educational apps in the content learning category (three apps), the informational management category (two apps), and the learning skills category (one app).

According to the ISTE standards, educational mobile app software in the knowledge constructor category could provide opportunities for students to curate resources and contents to construct knowledge. In the comparable study, educational apps in the content learning and the informational management categories, such as Pop Maths (solve math quiz) and Google search (search information), could also support learning by searching (curating resources) and solving (constructing knowledge). These apps could be classified in the knowledge constructor category. The discrepancy is mainly caused by different taxonomies and categories employed. The taxonomy employed in this study to classify educational mobile app software was the ISTE standards with seven categories while the comparable study employed a taxonomy with three broader categories.

Research Question Four

To answer research question four, *What are teachers' perceptions of the influence of integrating educational mobile app software on students' technology literacy?,* an inductive coding process was used to gain an in-depth understanding on how participants perceived the influence of integrating educational mobile app software on students' technology literacy in seven strands. A body of literature has illustrated that teachers' perceptions of integrating educational mobile app software played a crucial role in the influence on students' achievement (Koehler, Shin, & Mishra, 2012). Students' attitudes toward the use of educational mobile app software were correlated to teachers' perceptions as well (Sessions, et al., 2016). Additionally, Pittman and Gaines (2015) found that teachers' attitudes pertaining to the use of technology played a crucial role in technology integration.

Findings of the quantitative data analysis in this study from the online survey item 8, *If integrated appropriately, mobile application software could improve learning outcomes,* indicated that 36.5 percent of participants agreed and 63.5 percent strongly agreed that educational mobile app software could improve students' learning outcomes if integrated appropriately in classrooms. Findings of the qualitative data analysis in this study are in agreement with the quantitative findings. All teachers who participated in the semi-structured interviews or focus groups perceived a positive influence of integrating educational mobile app software on students' technology literacy. Additionally, findings are congruent with the suggestion that teachers perceived a positive impact of educational mobile app software use on learning and an improvement of students' engagement (Domingo & Garganté, 2016; Waters, et al., 2016).

The consensus among all participants of this study was that pedagogies in secondary schools are transforming from teacher-centered to student-centered learning. All participants perceived that technology literacy is essential for students to be successful. This is congruent with the assertion that skills to communicate, build spreadsheets, and process words are essential for future employment (Johnson, 2007). Additionally, this finding is in agreement with the suggestion that student-centered learning could support and develop 21st century skills through core subject knowledge learning by integrating educational technologies into classrooms (Kong et. al., 2014). Castek and Beach (2013) also agreed that educational mobile app software could support activities, such as communication, multimodality, and shared productivity, and provide opportunities to collaborate and accomplish a common task as a team.

Among all seven technology literacies, emergent themes from participants' responses illustrated that word processing, multimedia and presentations, and social and ethical literacies could be positively improved by integrating educational mobile app software. Most participants perceived that word processing literacy is a prominent skill for the fifth grade students to develop. Educational mobile app software could foster word processing literacy and assist students with writing difficulties by improving word processing literacy. This finding concurred with another study in which Judson (2010) concluded students used computers in schools to develop more word processing literacy than any other functions. The author also asserted word processing was the most commonly used technology literacy in schools.

Participants in this study also commented frequently on multimedia and presentations literacy. This literacy could allow students to demonstrate their creativity

and knowledge on any subjects by presenting to other students. Participants perceived that it would be suitable for elementary students to develop and master this literacy, especially in fifth grade before they branch into secondary schools. Microsoft PowerPoint was the most commonly used software to develop this literacy. Students curated resources and created multimedia artifacts, such as videos and pictures, and presented their creative products and ideas to other students. This finding is congruent with the assertion that visual cognition is crucial for students to retain information by using technology (Bester & Brand, 2013).

Social and ethical literacy is the ability to understand internet safety and identify ethical issues pertaining to communications and interactions online through social media or mobile application software (TechLiteracy Assessment, 2017). Most participants considered it a very important and crucial skill for elementary students. One participant even denoted it as a "monumental" skill to be developed as early as elementary school. An and Reigeluth (2011) asserted K-12 students of today were born and grew up with a wide array of technologies integrated into their daily lives. Despite that students were referred to as digital natives, many participants expressed a similar concern and commented that some students mostly interact and communicate using software applications. This literacy is crucial for students to understand rights and responsibilities when interacting socially and collaborating ethically with other learners in a digital world.

Additionally, findings in this study indicated that most participants expressed common concerns on how students socially behave and communicate. This echoed the suggestion from another study. Young (2014) disagreed on a common perception that

digital natives are “experts” on using technology especially to communicate ethically. The author suggested it is imperative to teach students the rules to properly navigate and ethically participate in a digital society in a digital world. Findings in this study concurred with this suggestion that it is crucial to instill social and ethical literacy in elementary students.

Research Question Five

To answer research question five, *What are teachers’ decision processes, methods, and criteria to search, identify, classify, and select educational mobile app software?,* an inductive coding process was used to explore how teachers find and evaluate the appropriateness and effectiveness of educational mobile app software. Findings of the quantitative data analysis from the online survey item 6, *A rubric can assist educators in effectively classifying, identifying, evaluating, and selecting educational mobile application software,* indicated that 50.8 percent of participants agreed and 49.2 percent strongly agreed that a rubric could assist educators in effectively classifying, identifying, evaluating, and selecting educational mobile app software. In addition, an inductive coding process derived three distinct themes including rubric, methods, and criteria.

Classification is one of the most central and conceptual practices and a foundation for conceptualization, statistics, and data analysis (Bailey, 1994). Lee and Cherner (2015) contended that educators need a valid and research-based rubric to assist them in classifying, analyzing, and evaluating quality of educational apps. In addition, Weng (2015) concluded a rubric was a useful instrument for educators to classify and select appropriate apps. Dombroviak and Ramnath (2007) contended that researchers and

practitioners could utilize the classification to understand complex domains such as educational mobile app software. In addition, the authors asserted taxonomy could help to identify commonalities and redundancies, and provide a simple method to compare, contrast, and understand the complexities and requirements of specific software.

In concert with these findings, all participants in this present study agreed, some very strongly, that a rubric would be helpful in assisting educators in identifying and selecting educational mobile app software. There was a concern expressed by the participants of this study that it would be challenging and difficult to find appropriate educational mobile app software from the various online app stores based on the way they are organized. This is congruent with another assertion that it could be challenging for educators to find appropriate apps. Teachers often make the mistake of using inappropriate apps by arbitrarily selecting apps without examining the educational quality of these apps (Ok, Kim, Kang, & Bryant, 2016). Shuler (2012) found that 86 percent of the most popular educational application software listed in the educational category at the iTunes store were not intended to be used in schools. Notari, Hielscher, and King (2016) concluded it could be difficult to identify and select appropriate educational apps in the app store markets. Findings in this present study support the assertion that a research-based rubric could assist educators in analyzing and evaluating quality of educational apps (Lee & Cherner, 2015).

Most participants in this study agreed that a taxonomy with the seven categories of the ISTE Standards for Students would be a great rubric to assist educators in classifying and identifying educational mobile app software. Buckler (2012) asserted there was a lack of an evaluation tool and centralized repository for users with special

needs. New teachers, as well as teachers with fewer years of teaching experience, are often in the process of trying to identify and select appropriate educational mobile app software to be integrated into their instruction. A rubric could greatly assist them in accomplishing this task. This study advanced literature by proposing an innovative framework to align classification and assessment by employing the ISTE standards as a taxonomy to classify educational mobile app software and empirically examine the influence of integrating educational mobile app software on students' technology literacy. This innovative framework supports the assertion that stronger alignment between the classification and assessment is needed. (Zydney & Warner, 2016).

In addition, findings in this study suggested participants employed an array of different methods to search, identify, and select educational mobile app software that met their instructional needs. The most common method shared by many participants was a self-assessment approach. By employing this method, teachers spent time themselves on reviewing or playing with educational mobile app software that they were interested in using. Another method was a test drive or pilot test approach. Participants evaluated educational mobile app software by testing the software on their family members or students in a pilot classroom. With this pilot test approach, participants utilized immediate feedback from the testers to determine if an educational software was effective. The third most commonly utilized method was getting referrals from their colleagues or subject matter experts through individual connections or Professional Learning Communities (PLCs).

To implement these methods, participants shared a variety of criteria that they utilized to evaluate and select educational mobile app software. These criteria included

ease of use and user friendliness, accessibility and compatibility, assessment and progress tracking, adequate levels of difficulty, and pricing of the educational mobile app software. Ease of use and user friendliness was the most prominent criterion. This finding concurs with the suggestion that students develop positive attitudes if they perceive a technology as easy to use and useful (Dündar, & Akçayır, 2014). Similarly, Buckler (2012) suggested the user interface is an important quality factor to evaluate educational mobile app software. Participants indicated that they are less likely to integrate educational mobile app software that is difficult to use or designed with a poor user interface.

Accessibility and compatibility were also popular criteria used by participants to evaluate educational mobile app software. Accessibility refers to how students launch and access educational mobile app software on mobile devices or computers. Compatibility is the ability to use educational mobile app software on a variety of devices, such as smartphones, tablets, laptops, or computers with different operational systems (OS's). Educational mobile app software designed to be compatible across a variety of platforms could provide better opportunities to extend learning if students can access them from their devices or computers at school or at home.

The ability to assess and track progress was another important criterion for teachers to consider when using educational mobile app software. The emergent themes included the ability to assess students' comprehension and keep track of how students were progressing. Istation and iReady were two software programs frequently mentioned by participants that provide the ability to assess students' learning and keep track of learning progress. Findings in this study are congruent with the conclusion in a meta-

analysis that there is a need for rigorous tools to assess students' technology literacy skills (Males, Bate, & Macnish, 2017). It also concurred with another assertion that teachers perceived a lack of assessment as a barrier to technology integration (An & Reigeluth, 2011). Educational mobile app software that has assessment tools built-in would greatly assist educators in tracking students' learning progress and mastery of intended instructional skills.

In addition, the ability to guide students through adequate levels of difficulty was also a common criterion utilized by participants in this study. Educational mobile app software with this ability could guide students' learning based on their level of mastery. Finally, pricing of educational mobile app software played an important role in teachers' decision-making process. Most participants integrated educational software because it is free of charge or already purchased by the district. Shuler (2012) concluded the average price of children's apps were $2.14 in 2011. It could cost $60 to install one software program on an iPad cart with 30 iPads. There is no known study that investigated the influence of pricing of educational mobile app software on students' learning outcome. Walker (2011) gave a few non-empirical examples on how price may not associate with the quality of educational mobile app software.

Research Question Six

To answer research question six, *What are teachers' perceptions regarding the ease of obtaining and integrating educational mobile app software?*, an inductive coding process was used to identify resources of educational mobile app software and the perceived barriers of educational software integration in classrooms. Findings of the quantitative data analysis from the online survey item 6, *It could be challenging to find*

and evaluate mobile application software for your instructional needs, indicated that 15.8 percent of participants disagreed, 42.9 percent agreed, and 41.3 percent strongly agreed that it could be challenging to acquire and integrate educational mobile application software for their instructional needs. An inductive coding process derived three distinct themes concerning challenges and barriers that could impede how educational mobile app software was integrated in classrooms. Participants perceived barriers including lack of time, lack of educational mobile app software, and lack of training and support.

There were several prominent reasons that could cause a lack of time in classrooms. The time crunch in teaching was the most commonly expressed concern shared by all participants across the multiple schools studied. A lack of instructional time had a tremendously negative influence on how teachers integrate educational software in teaching. Classroom scheduling, curricula and instruction, and administrative tasks were several reasons shared by participants that caused the time crunch in teaching. Classroom scheduling was the biggest one among these reasons. All participants were part of a two- or three-way split where each teacher teaches one or more of the common core subjects. Participants perceived that block scheduling would make it more difficult for teachers to integrate educational mobile app software into instruction compared to self-contained classes.

Curricula and instruction plans, such as curriculum pacing guides, also played a crucial role in how teachers arrange instructional time. It is congruent with findings in a body of studies related to the barriers of technology integration in classrooms. For example, Tallvid (2016) found that a lack of time was one of the barriers that could hinder the technology integration in classrooms. Additionally, findings in this present

study support the results concluded by An and Reigeluth (2011) that more than half of participants perceived that a lack of time and technology were prominent barriers to creating technology-enhanced and learner-centered classrooms.

In addition to these barriers, other teaching and administrative tasks, such as grading, parent conferences, meetings, tutorials, and Professional Learning Communities (PLCs), also attributed to the time crunch in teaching. The findings echoed a study that found teachers used their personal time to prepare and curate technology resources for teaching (Kervin, Verenikina, Jones, & Beath, 2013). Findings indicated that 87% of teachers spent more than one hour, and approximately, 27% spent two or more hours each day to support integration of technology in teaching. In addition, some teachers even reported spending more than 30 hours a week outside school hours doing administrative work.

Findings in this present study indicated there were a variety of resources that provided available educational mobile app software for teachers to integrate. The most common resources were campus librarians, subject matter experts, mentors, coaches, and PLCs. These resources were located at the local campus where teachers have direct and convenient access to them. Librarians were the most commonly utilized resources at the campus level where teachers obtained the information and a list of available educational mobile app software. Participants also sought advice on integration of educational mobile app software from resources, such as subject matter experts, head teachers of the core subjects, instructional coaches, and technology specialists. Even with these resources, most participants perceived there was a lack of resources and educational mobile app software.

Participants in this study predominantly used the educational mobile app software that was purchased or provided by the district. The main reason was that these apps were purchased, approved, and already loaded on iPads or computers. This finding supports the results from a meta-analysis study. Bingimlas (2009) concluded teachers possessed a strong desire to integrate educational technologies in their classrooms; however, a lack of access to resources was one of the perceived barriers to technology integration.

In addition to the resources at the campus and the district levels, educational conferences provide a myriad of sessions and workshops with in-depth and hands-on experiences for teachers who were in need of additional resources of educational mobile app software. A few participants obtained additional information for educational software by using educational conferences as resources, such as Region 4 Educational Service Center. However, findings also indicated that some participants perceived there was still a lack of available educational mobile app software that could meet their instructional needs. This finding is congruent with the common criticism that leadership and administrators often provide hardware for teachers to use in their classrooms, but without software to support teaching (Kucirkova, 2014). Teachers in need of more educational software sought additional information from other external resources. Researching online was another commonly used method to find additional resources.

Additionally, findings indicated that participants perceived that some barriers and challenges existed pertaining to the integration of educational mobile app software. Training and support were two areas in which participants expressed many concerns related to the integration of educational mobile app software in their classrooms. A lack of adequate training was a common concern expressed by most participants. Teachers

needed to be properly trained on how to integrate and troubleshoot issues to effectively integrate educational mobile app software in their classrooms. Findings in this study are congruent with the assertion that it is rare to find programs specifically for the integration of educational software in teachers' training or professional development (Elliot & Mikulas, 2012). Additionally, Kong, Looi, Chan, and Huang (2017) asserted the use of educational technologies for learning could be more powerful and effective if federal, state, and local governments pay more attention to teacher development programs.

Finally, there were some other barriers related to infrastructure that would bolster technology integration, including mobile devices, workstations, Wi-Fi networks, internet connections, and user authentications. These technological components were crucial to support the integration of educational mobile app software in classrooms. Most of the participants shared commonly experienced issues, such as Wi-Fi or internet not properly working during the instructional time in classrooms and inconsistent quality of mobile devices and computers in classrooms. These barriers could impede the influence of integrating educational mobile app software on students' technology literacy in the educational context.

Implications

There were several potential limitations for this study. One limitation was that students' technology literacy was assessed by the web-based TLA test in seven strands: database, multimedia and presentations, social and ethical, spreadsheets, systems and fundamentals, telecommunication and internet, and word processing. The influence of educational mobile app software was examined on these seven strands. The purposeful sample of the participants in this study was another limitation. It was limited to all fifth

grade students and fifth grade core subject teachers at 19 Title I elementary schools in a large suburban district in southeast Texas. Despite the limitations in this study, the findings have important implications for educators, administrators, governments, and researchers.

Findings in this study indicated statistically significant correlations existed between technology literacy and categorical choices of educational mobile app software. These findings could serve as a guideline for educators and administrators to improve the intended students' technology literacy by integrating educational mobile app software in specific categories. For example, integrating more educational mobile app software in the empowered learner and the knowledge constructor categories could be emphasized to improve multimedia and presentations literacy. Correspondingly, administrators could assist teachers at schools with lower scores in telecommunication and internet literacy in integrating more educational mobile app software classified in the knowledge constructor and the creative communicator categories.

Findings in this study indicated that participants perceived technology literacy is crucial for students to succeed in secondary schools and 21st century workplaces. It is imperative to develop and assess students' technology literacy at elementary grade levels. While the findings in this study could be generalized to populations or schools with similar student demographics, it is recommended to administer valid assessments and determine the proficiency and deficiency of students' technology literacy at each individual school. The web-based TLA test employed in this study is a service paid by the district studied. Many school districts may not have valid tools to assess students' technology literacy. Federal, state, and local governments and school districts could

develop standard-based technology literacy assessment tools and make them available to all school districts. Administrators should administer these technology literacy related assessment tools and empirically measure students' technology literacy for all students. Based on the results of the assessment, administrators should develop strategic plans to assist teachers in integrating educational mobile app software in certain categories to develop students' technology literacy improvement where improvement is needed.

Findings in this study indicated that there was no relationship between frequency of educational mobile apps software use and students' learning achievement. It is in disagreement with other studies (Domingo & Garganté, 2016). The discrepancy could be related to different populations of the studies. Caution should be used before generalizing this finding to other populations.

Teachers could predominately integrate educational mobile app software in certain categories because the educational mobile app software was either mandated to use or provided by the school districts. Integrating similar educational mobile app software repeatedly over time could reduce student interest and engagement and, consequently, reduce the effectiveness and influence in learning. Administrators could encourage teachers to integrate a variety of educational mobile app software to improve students' technology literacy based on the deficiency in certain technology literacy.

Teachers perceived that a rigorous rubric would greatly assist them in searching and identifying appropriate educational mobile app software to integrate in their classrooms. A rigorous rubric should comprise a standard-based taxonomy, such as the ISTE Standards, to classify educational mobile app software. In addition, a rubric should include a definition of each category and the correlations pertaining to intended

technology literacy. For example, educational mobile app software in the knowledge constructor category is defined as a software program that allows students to take an active role in selecting a learning path and achieving a learning goal. By integrating educational mobile app software in the knowledge constructor category, students' technology literacies, such as multimedia and presentations, social and ethical, spreadsheets, telecommunication and internet, and word processing technology could be positively improved.

With estimated more than a million educational mobile app software available at the app stores in 2015 (Deng, Offutt, Ammann, & Mirzaei, 2017), it continues to be both challenging and difficult for educators and parents to find appropriate educational mobile app software (Murray & Olcese, 2011; Park, 2011). By developing and utilizing a rigorous rubric, administrators could constantly search, evaluate, and provide up-to-date educational mobile app software in a variety of categories to balance and improve students' technology literacy.

Many challenges and barriers shared by the participants in this study could impede the effectiveness of educational mobile app software integration in classrooms. Administrators should consistently communicate with stakeholders, including students, parents, teachers, and technology support, to identify and evaluate issues, priorities, and needs. Based on the evaluations, leadership should make informed decisions and embark on strategic planning to implement necessary interventions that could overcome barriers and provide training and technology support to improve effectiveness of educational mobile app software integration.

A lack of resources could hinder the effectiveness of integrating educational mobile app software in classrooms. Inequity in funding allocations could limit the resources and budget for administrators and educators to acquire appropriate educational mobile app software to meet their instructional needs. Federal and state education agencies should communicate with local governments and school districts to distribute funds and resources to overcome specific challenges and barriers pertaining to the integration of educational mobile app software in classrooms.

Students' safety, identities, rights, responsibilities, and learning opportunities in a digital world should be the top priority for all administrators and educators. Education agencies at the federal and state level should design curriculum and instruction that could develop social and ethical literacy in digital learning environments. Districts and schools may have provided instructional materials to foster social and ethical literacy as part of the curriculum. However, most of the instructions are in forms of watching videos or lecturing by instructors. Social and ethical literacy could be developed by integrating educational mobile app software that is specifically designed for students to socially and collaboratively participate and learn in a managed and safe environment where teachers guide and mediate their behaviors. It is imperative for administrators to identify and provide appropriate and effective educational mobile app software to develop students' social and ethical literacy as early primary school.

Recommendations for Future Research

The purpose of this mixed methods study was to employ the ISTE standards as a taxonomy to classify educational mobile app software and empirically examine the influence on students' technology literacy. The ISTE Standards for Students emphasizes the technology literacy that enables students to engage and thrive in a connected digital world. This study proposed an innovative framework that employs the ISTE Standards for Students to interweave the taxonomy, curriculum and instruction, and technology literacy assessment as illustrated in Figure 2.2. The seven categories of ISTE Standards for Students were used as a taxonomy to classify educational mobile app software. TEKS and TA standards for public schools were developed by the Texas Education Agency to align with the ISTE standards. The TLA is an ISTE standard-based online assessment tool to measure students' technology literacy. Findings in this study provided insights into the intricate correlations between the categories of educational mobile app software and students' technology literacy. Despite some limitations of this study, several recommendations were suggested for future research.

The first recommendation is to develop future studies that could replicate the study and expand to larger populations with diverse demographics across different regions and states. Schools across different districts or regions with similar student ethnicity or socio-economic status could participate in future studies. Data collected from larger populations would provide rigorous information to validate the findings.

The second recommendation is to employ a variety of research designs to delve into the correlations between the categorical choices of educational mobile app software and technology literacy. Findings in this study indicated statistically significant

correlations existed between certain technology literacy and categories of educational mobile app software used in classrooms. These correlations are complicated and multifaceted. Educational mobile app software in one category could influence multiple technology literacy skills. One technology literacy could be reflective of integrating educational mobile app software in multiple categories.

For future quantitative studies, an experimental research design could be employed to determine the effectiveness of integrating educational mobile app software in certain categories. Teachers in treatment groups could integrate educational mobile app software in the selected categories. An analysis of covariance (ANCOVA) test could be used to determine the differences in mean responses between different groups.

Additionally, researchers could employ a pre- and post-assessment design to examine the influence of integrating educational mobile app software in different categories on students' technology literacy. Teachers select educational mobile app software in certain categories to be integrated into instruction. Researchers administer a pre-assessment and post-assessment before and after the implementation of an intervention program. An independent sample t-test could be used to determine the influence of the integrated educational software on students' technology literacy.

For future qualitative studies, researchers could employ a grounded theory approach to seek in-depth understanding and insights on how teachers perceive the relationship between categories of educational mobile app software and technology literacy. A grounded theory case study could be employed to investigate the reason, purpose, and intended outcome for using specific apps that teachers selected. More studies are recommended to investigate the resources utilized and the reactions pertaining

to the integration of educational mobile app software. Findings from future qualitative studies could triangulate with the quantitative results for policy makers and administrators to make informed decisions on best practice of integrating educational mobile app software in classrooms.

Conclusion

Educational mobile app software could provide ample opportunities to foster learning and improve students' technology literacy. Findings in this study indicated that technology literacy scores were reflective of integrating educational mobile app software. Kong, et al. (2014) suggested that public schools should value the role of educational technologies in fostering the student-centered learning process and developing technology literacy in the educational context. It is imperative to delve into the knowledge of the relationship between the integration of educational mobile app software and students' technology literacy. There was estimated to be over a million apps available in 2015 (Deng, et al., 2017). A rubric with standard-based taxonomy and intended improvement in technology literacy could greatly assist administrators and educators in evaluating and integrating appropriate educational mobile app software in classrooms. Leadership in governments and school districts play a crucial role in identifying and mitigating technologies related challenges and barriers to support educational mobile app software integration. The ultimate goal is to effectively integrate appropriate educational mobile app software in classrooms and equip students with technology literacies to succeed in 21st century learning environments and workplaces.

REFERENCES

An, Y. J., & Reigeluth, C. (2011). Creating technology-enhanced, learner-centered classrooms: K–12 teachers' beliefs, perceptions, barriers, and support needs. *Journal of Digital Learning in Teacher Education, 28*(2), 54-62.

Ananiadou, K., & Claro, M. (2009), 21st century skills and competences for new millennium learners in OECD countries. *OECD Education Working Papers*, No. 41, OECD Publishing. 1-33. Retrieved from http://dx.doi.org

Aparicio, M., Bacao, F., & Oliveira, T. (2016). An e-Learning theoretical framework. *Journal of Educational Technology & Society, 19*(1), 292-307.

Bailey, K. D. (1994). *Typologies and taxonomies: An introduction to classification techniques*. Thousand Oaks, CA: Sage Publications.

Bertrand, M., & Mullainathan, S. (2001). Do people mean what they say? Implications for subjective survey data. *The American Economic Review*, *91*(2), 67-72.

Bester, G. B., & Brand, L. (2013). The effect of technology on learner attention and achievement in the classroom. *South African Journal of Education, 33*(2), 1-15.

Bingimlas, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. *Eurasia Journal of Mathematics, Science & Technology Education, 5*(3), 235-245.

Bouck, E. C., Satsangi, R., & Flanagan, S. (2016). Focus on inclusive education: Evaluating software for students with disabilities: Supporting academic access and success. *Childhood Education, 92*(4), 324-328.

Buckler, T. (2012). Is there an app for that? Developing an evaluation rubric for app for use with adults with special needs. *The Journal of BSN Honors Research, 5(1),* 19-32.

Castek, J., & Beach, R. (2013). Using apps to support disciplinary literacy and science learning. *Journal of Adolescent & Adult Literacy, 56*(7), 554-564.

Cherner, T., Dix, J., & Lee, C. (2014). Cleaning up that mess: A framework for classifying educational apps. *Contemporary Issues in Technology and Teacher Education, 14*(2), 1-61.

Chiong, C., & Shuler, C. (2010). *Learning: Is there an app for that?* Paper presented at the Investigations of Young Children's Usage and Learning with Mobile Devices and Apps. New York: The Joan Ganz Cooney Center at Sesame Workshop.

Cognition and Technology Group at Vanderbilt. (1990). Anchored instruction and its relationship to situated cognition. *Educational Researcher, 19(6),* 2-10.

Cobcroft, R. S., Towers, S., Smith, J., & Bruns, A. (2006). Mobile learning in review: Opportunities and challenges for learners, teachers and institutions. *Proceedings at Online Learning and Teaching (OLT) conference*. Brisbane, Australia: Queensland University of Technology. Retrieved from http://citeseerx.ist.psu.edu/

Cohen, J. (1988). *Statistical power analysis for behavioral sciences* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum.

Common Core State Standards Initiative, (n.d.). *About the Standards*. Retrieved from http://www.corestandards.org

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage.

Crompton, H. (2013). A historical overview of mobile learning: Toward learner-centered education. In Z. L. Berge & L. Y. Muilenburg (Ed.), *Handbook of mobile learning* (pp. 3–14). Florence, KY: Routledge.

Crompton, H., Burke, D., Gregory, K. H., & Gräbe, C. (2016). The use of mobile learning in science: A systematic review. *Journal of Science Education and Technology, 25*(2), 149-160.

Davies, R. S. (2011). Understanding technology literacy: A framework for evaluating educational technology integration. *TechTrends, 55*(5), 45-52.

Davis, L.L. (1992). Instrument review: Getting the most from your panel of experts. Applied Nursing Research, *5*(4), 194–197.

Deng, L., Offutt, J., Ammann, P., & Mirzaei, N. (2017). Mutation operators for testing Android apps. *Information and Software Technology, 81*(C), 154-168.

Department of Education. (n.d.). *Improving Basic Programs Operated by Local Educational Agencies (Title I, Part A)*. Retrieved from https://www2.ed.gov

Dombroviak, K. M., & Ramnath, R. (2007). *A taxonomy of mobile and pervasive applications.* Paper presented at the Proceedings of the 2007 ACM symposium on Applied computing.

Domingo, M. G., & Garganté, A. B. (2016). Exploring the use of educational technology in primary education: Teachers' perception of mobile technology learning impacts and applications' use in the classroom. *Computers in Human Behavior, 56*, 21-28.

Dündar, H., & Akçayır, M. (2014). Implementing tablet PCs in schools: Students' attitudes and opinions. *Computers in Human Behavior, 32*(0), 40-46.

Elliot, S., & Mikulas, C. (2012). *Improving student learning through teacher technology training: A study of the effectiveness of technology integration training on student achievement*. Paper presented at the Society for Information Technology & Teacher Education international conference 2012.

Eyyam, R., Ramadan, E., & Hüseyin, S. Y. (2014). Impact of use technology in mathematics lessons on student achievement and attitudes. *Social behavior and personality, 42*, 31-40.

Fabian, K., Topping, K. J., & Barron, I. G. (2016). Mobile technology and mathematics: Effects on students' attitudes, engagement, and achievement. *Journal of Computers in Education, 3*(1), 77-104.

Hechter, R. P., & Vermette, L. A. (2013). Technology integration in K-12 science classrooms: An analysis of barriers and implications. *Themes in Science & Technology Education, 6*(2), 73-90.

Hill, C., & Heard, T. (2010). Technology Literacy in Fort Bend ISD. *Retrieved February, 12*, 2017 from http://www.fortbendisd.com

Hilton, A. (2016). Engaging primary school students in mathematics: Can iPads make a difference? *International Journal of Science and Mathematics Education*, 1-21.

Hirsh-Pasek, K., Zosh, J. M., Golinkoff, R. M., Gray, J. H., Robb, M. B., & Kaufman, J. (2015). Putting education in “educational” app lessons from the science of learning. *Psychological Science in the Public Interest, 16*(1), 3-34.

Hsin, C. T., Li, M. C., & Tasi, C. C (2014). The influence of young children's use of technology on their learning: A review. *Journal of Educational Technology & Society, 17*(4), 85-99.

Hutchison, A., Beschorner, B., & Schmidt-Crawford, D. (2012). Exploring the use of the iPad for literacy learning. *The Reading Teacher, 66*(1), 15-23.

Hwang, G. J., & Wu, P.-H. (2014). Applications, impacts and trends of mobile technology-enhanced learning: A review of 2008–2012 publications in selected SSCI journals. *International Journal of Mobile Learning and Organisation, 8*(2), 83-95.

ISTE (2016). *ISTE Standards for Students*. Retrieved from http://www.iste.org

ISTE (2017). *ISTE Seal of Alignment*. Retrieved from http://www.iste.org

Jara, I., Claro, M., Hinostroza, J. E., San Martín, E., Rodríguez, P., Cabello, T., . . . Labbé, C. (2015). Understanding factors related to Chilean students' digital skills: A mixed methods analysis. *Computers & Education, 88*, 387-398.

Johnson, G. M. (2007). Functional Internet literacy: Required cognitive skills with implications for instruction. *E-Learning and Digital Media, 4*(4), 433-441.

Johnson, L., Adams-Becker, S., Estrada, V., and Freeman, A. (2015). *NMC Horizon Report: 2015 K-12 Edition*. Austin, Texas: The New Media Consortium.

Jones, A. C., Scanlon, E., & Clough, G. (2013). Mobile learning: Two case studies of supporting inquiry learning in informal and semiformal settings. *Computers & Education*, *61*, 21-32.

Judson, E. (2010). Improving technology literacy: Does it open doors to traditional content? *Educational Technology Research and Development, 58*(3), 271-284.

Kearney, M., Burden, K., & Rai, T. (2015). Investigating teachers' adoption of signature mobile pedagogies. *Computers & Education, 80,* 48-57.

Kearney, M., Schuck, S., Burden, K., & Aubusson, P. (2012). Viewing mobile learning from a pedagogical perspective. *Research in Learning Technology, 20*(1), 1-17.

Keengwe, J., Pearson, D., & Smart, K. (2009). Technology integration: Mobile devices (iPods), constructivist pedagogy, and student learning. *AACE Journal*, *17*(4), 333-346.

Kervin, L., Verenikina, I., Jones, P., & Beath, O. (2013). Investigating synergies between literacy, technology and classroom practice. *Australian Journal of Language & Literacy*, *36*(3), 135-147.

Kiger, D., Herro, D., & Prunty, D. (2012). Examining the influence of a mobile learning intervention on third grade math achievement. *Journal of Research on Technology in Education, 45*(1), 61-82.

Kobelsky, K., Larosiliere, G., & Plummer, E. (2014). The impact of information technology on performance in the not-for-profit sector. *International Journal of Accounting Information Systems, 15*(1), 47-65.

Koehler, M. J., Shin, T. S., & Mishra, P. (2012). How do we measure TPACK? Let me count the ways. *Educational technology, teacher knowledge, and classroom*

impact: A research handbook on frameworks and approaches (pp. 16-31). Hershey, PA: IGI Global.

Kong, S. C., Chan, T.-W., Griffin, P., Hoppe, U., Huang, R., Kinshuk, . . . Yu, S. (2014). E-learning in school education in the coming 10 years for developing 21st century skills: Critical research issues and policy implications. *Journal of Educational Technology & Society, 17*(1), 70-78.

Kong, S. C., Chan, T.-W., Huang, R., & Cheah, H. M. (2014). A review of e-Learning policy in school education in Singapore, Hong Kong, Taiwan, and Beijing: implications to future policy planning. *Journal of Computers in Education, 1*(2-3), 187-212.

Kong, S.-C., Looi, C.-K., Chan, T.-W., & Huang, R. (2017). Teacher development in Singapore, Hong Kong, Taiwan, and Beijing for e-Learning in school education. *Journal of Computers in Education, 4*(1), 5-25.

Kozma, R. B. (1991). Learning with media. *Review of Educational Research, 61*(2), 179-211.

Kucirkova, N. (2014). iPads in early education: Separating assumptions and evidence. *Frontiers in Psychology, 5*. 1-3.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*: New York, NY: Cambridge University Press.

Learning.com (2017). *Retrieve Score Reports*. Retrieved from https://platform.learning.com

Lee, C. Y., & Cherner, T. S. (2015). A comprehensive evaluation rubric for assessing instructional apps. *Journal of Information Technology Education: Research, 14*, 21-53.

Looi, C. K., Seow, P., Zhang, B., So, H. J., Chen, W., & Wong, L. H. (2010). Leveraging mobile technology for sustainable seamless learning: A research agenda. *British Journal of Educational Technology, 41*(2), 154-169.

Males, S., Bate, F., & Macnish, J. (2017). The impact of mobile learning on student performance as gauged by standardized test (NAPLAN) scores. *Issues in Educational Research, 27*(1), 99-114.

Martin, W., Sarro, F., Jia, Y., Zhang, Y., & Harman, M. (2016). A survey of software store analysis for software engineering. *RN, 16*, 02. Retrieved from http://www.cs.ucl.ac.uk

McCandless J. (2015). U.S. Education Institutions Spend $6.6 Billion on IT in 2015. Retrieved from http://www.centerdigitaled.com/

Merchant, G. (2012). Mobile practices in everyday life: Popular digital technologies and schooling revisited. *British Journal of Educational Technology, 43*(5), 770-782.

Mohapatra, D., Mohapatra, M., Chittoria, R., Friji, M., & Kumar, S. (2015). The scope of mobile devices in health care and medical education. *International Journal of Advanced Medical and Health Research, 2*(1), 3-8.

Mouza, C. (2008). Learning with laptops: Implementation and outcomes in an urban, under-privileged school. *Journal of Research on Technology in Education, 40*(4), 447-472.

Murray, O. T., & Olcese, N. R. (2011). Teaching and learning with iPads, ready or not? *TechTrends, 55*(6), 42-48.

Nickerson, C. R., Varshney, U., & Muntermann, J. (2013). A method for taxonomy development and its application in information systems. *European Journal of Information Systems, 22*(3), 336-359.

Notari, M. P., Hielscher, M., & King, M. (2016). Educational software ontology. In D. Churchill, J. Lu, K. F. T. Chiu, & B. Fox (Eds.), *Mobile Learning Design: Theories and Application* (pp. 83-96). Singapore: Springer Singapore.

Ok, M. W., Kim, M. K., Kang, E. Y., & Bryant, B. R. (2016). How to find good apps: An evaluation rubric for instructional software for teaching students with learning disabilities. *Intervention in School and Clinic, 51*(4), 244-252.

Park, Yeonjeong. (2011). A pedagogical framework for mobile learning: Categorizing educational applications of mobile technologies into four types. *The International Review of Research in Open and Distributed Learning 12 (2)*:78-102.

Pittman, T., & Gaines, T. (2015). Technology integration in third, fourth and fifth grade classrooms in a Florida school district. *Educational Technology Research and Development, 63*(4), 539-554.

Public Broadcasting Service. (2013). *PBS Survey Finds Teachers Are Embracing Digital Resources to Propel Student Learning* [Press release]. Retrieved from http://www.pbs.org/about/blogs/news/pbs-survey-finds-teachers-are-embracing-digital-resources-to-propel-student-learning/.

QSR International Pty Ltd. (2016). *What is NVivo*?. Retrieved from http://www.qsrinternational.com

Region 4 Education Service Center (2017). *Region 4 Professional Development*. Retrieved from https://www.escweb.net

Roland, J. (2006). Measuring up. *Learning & Leading with Technology, 34*(2), 12–17.

Rubio, D. M., Berg-Weger, M., Tebb, S. S., Lee, E. S., & Rauch, S. (2003). Objectifying content validity: Conducting a content validity study in social work research. *Social Work research, 27*(2), 94-104.

Sessions, L., Kang, M. O., & Womack, S. (2016). The Neglected "R": Improving Writing Instruction Through iPad apps. *TechTrends, 60*(3), 218-225.

Searson, M., Hancock, M., Soheil, N., & Shepherd, G. (2015). Digital citizenship within global contexts. *Education and Information Technologies, 20*(4), 729-741.

Shroff, R. H., Keyes, C., & Linger, W. (2015). A proposed taxonomy of theoretical and pedagogical perspectives of mobile applications to support ubiquitous learning. *Ubiquitous Learning: An International Journal, 8*(4), 23-44.

Shuler, C. (2012). *iLearn II: An analysis of the education category of the iTunes app Store*. New York, NY: The Joan Ganz Cooney Center at Sesame Workshop.

State Educational Technology Directors Association (2007). *2007 Technology Literacy Assessment and Educational Technology Standards Report*. Retrieved from http://www.setda.org

Stein, S. J., Shephard, K., & Harris, I. (2011). Conceptions of e-learning and professional development for e-learning held by tertiary educators in New Zealand. *British Journal of Educational Technology, 42*(1), 145-165.

Suchman, L. A. (1987). *Plans and situated actions: The problem of human-machine communication*. New York, NY: Cambridge University Press.

Tallvid, M. (2016). Understanding teachers' reluctance to the pedagogical use of ICT in the 1:1 classroom. *Education and Information Technologies, 21*(3), 503.

TechLiteracy Assessment (2017). *TechLiteracy Assessment*. Retrieved from http://www.learning.com

TEA (2012). *Texas Essential Knowledge and Skills for Technology Applications*. Retrieved from http://ritter.tea.state.tx.us

TEA (2016). *2014–15 Texas Academic Performance Reports*. Retrieved from https://rptsvr1.tea.texas.gov

TEA (2016a). *Title I, Part A Campus Listing by District*. Retrieved from http://tea.texas.gov

TEA (2017). *No Child Left Behind and Elementary and Secondary Education Act*. Retrieved from http://tea.texas.gov/About_TEA/Laws_and_Rules/NCLB_and_ESEA/No_Child_Left_Behind_and_Elementary_and_Secondary_Education_Act/.

The White House. (2013). *ConnectED*. Retrieved from https://www.whitehouse.gov/issues/education/k-12/connected.

Traxler, J., & Vosloo, S. (2014). Introduction: The prospects for mobile learning. *Prospects, 44*(1), 13-28.

Voogt, J., & Roblin, N. P. (2012). A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies. *Journal of Curriculum Studies, 44*(3), 299-321.

Vu, P., McIntyre, J., & Cepero, J. (2014). Teachers' use of the iPad in classrooms and their attitudes toward using it. *Journal of Global Literacies, Technologies, and Emerging Pedagogies, 2*(2), 58-74.

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Walker, H. (2011). Evaluating the effectiveness of apps for mobile devices. *Journal of Special Education Technology, 26*(4), 59-63.

Wang, F., Kinzie, M., McGuire, P., & Pan, E. (2010). Applying technology to inquiry based learning in early childhood education. *Early Childhood Education Journal, 37*(5), 381-389.

Waters, S., Kenna, J., & Bruce, D. (2016). Apps-outely perfect! Apps to support common core in the history/social studies classroom. *Social Studies, 107*(3), 1-7.

Weng, P.-L. (2015). Developing an app evaluation rubric for practitioners in special education. *Journal of Special Education Technology, 30*(1), 43-58.

Wilson, M. L., & Zietz, J. (2004). Systematic bias in student self-reported data. *Journal for Economic Education, 4*(4), 13-19.

Wu, W.-H., Wu, Y.-C. J., Chen, C.-Y., Kao, H.-Y., Lin, C.-H., & Huang, S.-H. (2012). Review of trends from mobile learning studies: A meta-analysis. *Computers & Education, 59*(2), 817-827.

Young, D. (2014). A 21st-century model for teaching digital citizenship. *Educational Horizons, 92*(3), 9-12.

Zydney, J. M., & Warner, Z. (2016). Mobile app for science learning: Review of research. *Computers & Education, 94*, 1-17.

APPENDIX A

SURVEY COVER LETTER

APPENDIX A

SURVEY COVER LETTER

April 2017

Dear Southeast Independent School District fifth grade teacher,

Greetings! You are being selected to complete the online *Educational Applications (Apps) Categories and Usage Survey*. The purpose of this study is to classify and examine the influence of educational apps on students' technology literacy. This study will employ the newly revised 2016 International Society for Technology in Education (ISTE) Standards for Students to classify and empirically examine how educational apps influence students' technology literacy.

Your participation will be completely voluntary. You will not be asked to give your name, gender, or race/ethnicity as part of the survey. Your responses and identities will remain anonymous. Data collected from this online survey will allow the researcher to determine years of experience, core subject area, the numbers, the names, and the categories of educational apps used by 5th grade teachers at 19 Title I elementary schools. Data will be analyzed to examine if there is a statistically significant relationship between the different categories of educational apps and the students' technology literacy. Findings will be shared with educators and administrators.

You will be asked to list 5 most frequently used educational apps in your 5th grade classrooms during school hours in 2016-2017 school year during the survey. Please try to answer all of the questions in this online survey. Your participation is completely voluntary, but answering each response will make the survey most useful.

This online survey will take approximately 5 to 10 minutes to complete. It will work on any computer or mobile device. It is advised to take the survey after school hours. No obvious undue risks will be endured and you can stop your participation at any time. In addition, there will be no benefit directly from your participation in this study. Your participation is greatly appreciated. Completion of the online survey will imply your consent.

There are very little known studies that examine the influence of educational apps on students' technology literacy. Your completion of this online survey is not only greatly appreciated but invaluable. If you have any further questions, please feel free to contact the researcher at (mingtwu@outlook.com). Thank You!

Please click on the following link to complete the survey: **<link to the online survey>**

Sincerely,

Ming Twu
mingtwu@outlook.com
Doctoral Candidate
College of Education
University of Houston-Clear Lake

APPENDIX B

EDUCATIONAL MOBILE APPLICATION SOFTWARE CATEGORIES AND USAGE SURVEY

APPENDIX B

EDUCATIONAL MOBILE APPLICATION SOFTWARE CATEGORIES AND USAGE SURVEY

Section 1 - Educational Application (App) Related Questions (5 Items)

1. Please select your school.

☐ A.	☐ B. A.	☐ B. B.	☐ B. C.	☐ E. A.
☐ F.	☐ G. A.	☐ G. B.	☐ H. R.	☐ H. A.
☐ H. B.	☐ L. L.	☐ M. B.	☐ M. G.	☐ M. W.
☐ P.	☐ R. A.	☐ R. B.	☐ T.	

2. How many educational mobile application software did you use in the 2016-2017 school year?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 -10 ☐ 10 - 20 ☐ More than 20

Note: Question 3 through 5 will be automatically repeated 5 times on qualtrics.com for top five most frequently used apps.

3. List the name of a mobile application software you used frequently?

_____

4. How often do you use this mobile application software?

☐ Once a day	☐ 2-4 times a day	☐ Once a week	☐ 2–4 times a week
☐ Once a month	☐ 2-4 a month	☐ Once a semester	☐ 2-4 times a semester
☐ Once a school year	☐ 2-4 times a school year		

5. Please select the most appropriate category(ies) for this mobile application software. (Select all that apply)

☐ Empowered Learner	☐ Digital Citizen	☐ Knowledge Constructor	Innovative Designer
☐ Computational Thinker	☐ Creative Communicator	☐ Global Collaborator	

Note: Questions 3 to 5 will be repeated 4 times for 5 most frequently used educational mobile application software.

Section 2 - Perceptions Related Questions (3 items)

6. A rubric could assist educators in effectively classifying, identifying, evaluating, and selecting educational mobile application software.

(*For example, an app classified as "Creative Communicator" will allow students to express themselves creatively and communicate clearly.)*

☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

7. It could be challenging to find and evaluate educational mobile application software for your instructional needs.

☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

8. If integrated appropriately, educational mobile application software could improve learning outcomes.

☐ Strongly Disagree ☐ Disagree ☐ Agree ☐ Strongly Agree

Section 3 - General Questions

9. How many years of teaching experience do you have?

☐ 0 ☐ 1 - 5 ☐ 6 -10 ☐ 11 - 20 ☐ More than 20

10. Which core subject area(s) did you teach during the 2016-2017 school year?

☐ Mathematics ☐ Science ☐ English Language Arts ☐ Social Studies ☐ Other:_____

APPENDIX C

INFORMED CONSENT

APPENDIX C

INFORMED CONSENT

You are being selected to participate in the research project described below. Your participation in this study is completely voluntary and you may refuse to participate, or you may decide to stop your participation at any time. Should you refuse to participate in the study or should you withdraw your consent and stop participation in the study, your decision will involve no penalty nor loss of benefits to which you may be otherwise entitled. You are being asked to read the information below carefully, and ask questions about anything you don't understand, and sign this consent form before participating in the focus group.

Title: Examining The Influence of Educational Mobile Application Software on Students' Technology Literacy

Student Investigator: Ming Twu
Faculty Sponsor: Jana Willis, Ph.D.

PURPOSE OF THE STUDY

The purpose of this study is to examine the influence of educational mobile application (app) software on students' technology literacy.

PROCEDURES

The population of this study will comprise of all 19 Title I elementary schools. A purposeful sample of fifth grade teachers at 19 Title I elementary schools will be asked to provide responses to an online survey. Data collected from the item 2 on the online survey, How many educational apps do you use in 2016-2017 school year?, will be aggregated to the school level to represent the average number of educational apps used at each 19 Title I elementary school. Fifth grade teachers at schools with a higher average number of educational apps used will be invited to participate in follow-up focus groups or individual interviews. The responses in the focus groups or individual interviews will be recorded and transcribed verbatim to ensure integrity and accuracy of data analysis.

EXPECTED DURATION

The total anticipated time commitment would be approximately 90 minutes.

RISKS OF PARTICIPATION

There are no anticipated risks associated with participation in this project.

BENEFITS TO THE SUBJECT

There is no direct benefit received from your participation in this study. Your participation will help the researchers better understanding the influence of educational software on student's technology literacy.

CONFIDENTIALITY OF RECORDS

Every attempt will be made to be as neutral and objective as possible and not to impose the researcher's beliefs on this topic upon any of the participants. No other teachers or principals will know who participated. Only the participants know who participated in the focus group. The researcher of this study will conduct the focus groups. No additional person will be allowed to attend the focus group sessions except the participants and the researcher of this study. You are being asked not to share participants' responses outside of the focus groups. Every attempt will be made to continuously safeguard against unsupported and subjective interpretations as themes emerged. Pseudonyms will be assigned to protect the confidentiality of all participants, campuses, and the district. All information will be transcribed from the audio recording to provide utmost accuracy and to establish both the internal and external validity of the study. Data collected from the focus groups will be used for educational and publication purposes. At all time, all data collected will be stored on the researcher's home computer hard drive and on a separate Universal Serial Bus (USB) memory drive secured by the researcher. The researcher will keep all data protected in a filing cabinet in a locked storage facility and ensured that all electronic data will be password protected on storage devices. For federal audit purposes, the participant's documentation for this research project will be maintained and safeguarded by the researcher for a minimum of five years after completion of the study. After that time, the participant's documentation may be destroyed.

FINANCIAL COMPENSATION

There is no financial compensation to be offered for participation in the study.

INVESTIGATOR'S RIGHT TO WITHDRAW PARTICIPANT

The investigator has the right to withdraw you from this study at any time.

CONTACT INFORMATION FOR QUESTIONS OR PROBLEMS

The investigator has offered to answer all your questions. If you have additional questions during the course of this study about the research or any related problem, you may contact the Student Researcher, Ming Twu, at phone number 281-634-1066 or by email at mingtwu@outlook.com. The Faculty Sponsor Jana M. Willis, Ph.D. may be contacted by email at willis@uhcl.edu.

SIGNATURES:

Your signature below acknowledges your voluntary participation in this research project. Such participation does not release the investigator(s), institution(s), sponsor(s) or granting agency(ies) from their professional and ethical responsibility to you. By signing the form, you are not waiving any of your legal rights.

The purpose of this study, procedures to be followed, and explanation of risks or benefits have been explained to you. You have been allowed to ask questions and your questions have been answered to your satisfaction. You have been told who to contact if you have additional questions. You have read this consent form and voluntarily agree to participate as a subject in this study. You are free to withdraw your consent at any time by contacting the Student Researcher or Faculty Sponsor. You will be given a copy of the consent form you have signed.

Subject's printed name:_____

Signature of Subject:_____

Date:_____

Using language that is understandable and appropriate, I have discussed this project and the items listed above with the subject.

Printed name and title:_____

Signature of Person Obtaining Consent:_____

Date:
_____

THE UNIVERSITY OF HOUSTON-CLEAR LAKE (UHCL) COMMITTEE FOR PROTECTION OF HUMAN SUBJECTS HAS REVIEWED AND APPROVED THIS PROJECT. ANY QUESTIONS REGARDING YOUR RIGHTS AS A RESEARCH SUBJECT MAY BE ADDRESSED TO THE UHCL COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS (281-283-3015). ALL RESEARCH PROJECTS THAT ARE CARRIED OUT BY INVESTIGATORS AT UHCL ARE GOVERNED BY REQUIREMENTS OF THE UNIVERSITY AND THE FEDERAL GOVERNMENT. (FEDERALWIDE ASSURANCE # FWA00004068)

APPENDIX D

INTERVIEW GUIDE

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INTERVIEW GUIDE

1. *What resources provide available apps for you to consider to use in your classroom?* (Colleagues, the district's digital learning specialist, professional development, PLC, Google search, blogs, etc. For example, a colleague mentioned a cool app that sounds very interesting to you.).

Subquestions:

   a. How did you make the decision to use the apps you picked for this school year? (Please explain with a few apps you used in classrooms.)
   b. What is your criteria or method to evaluate apps that will meet your educational needs? (Please explain.)
   c. How do you use apps in your classroom? (Please give examples on the most frequently used app)
   d. What is your perception could educational apps improve students' achievement? (Please explain.)

2. *How do you know if the apps you used are effective?* (Please explain how you assess the impact on students' learning outcomes.).

Subquestions:

   a. In additional to the evidence-based assessment, such as observations, do you think it would be helpful to formatively measure students' achievement related to the use of educational apps, such as central tendency?
   b. What is your perception of using standardized tests, such as STAAR, to measure the influence of educational apps?
   c. Do you think a higher frequency of app use, regardless of categories, could have higher impact students' literacy in general? (Please explain.)
   d. Do you think a higher number of apps use, regardless of categories, could have a higher impact on students' literacy in general? (Please explain.)

3. *Could educational apps to improve literacy?* (Please explain with examples of apps you used.).

Subquestions:

   a. Do you think that specific technology literacy could be reflective of using certain categories of apps as listed in Table 2? (Please explain with examples.)
   b. From the different perspective, do you think that apps in certain categories could improve specific technology literacy? (Please explain with examples.)
   c. Please think about the apps you are using this year. Which categories best fit them? Which technology literacy could be improved? (Please explain with one or two apps.)
   d. Are there any of these 7 categories that you never use apps in? What could be the reasons? For example, you are not aware of any apps or you are not sure how to use them?

4. There were approximate 200,000 apps classified as “educational” in the iTunes store as of July 2016. *What are your thoughts on how apps are organized and classified in app stores?*

Subquestions:

a. If you are to develop a way to classify educational apps, what would the taxonomy look like? (Please explain.)
b. What is your perception of having a rubric to assist you finding the appropriate app for your specific instructional needs? (Please explain.)
c. Do you think that a rubric using the 7 ISTE categories would be helpful for educators and parents to search, identify, evaluate, and select educational apps that are appropriate and suitable for their learning needs? (Please explain.)
d. To measure the influence of apps on technology skills, is it important to use a technology standard classification? (Please explain.)
e. What were the challenges, difficulties, or barriers that you encountered on searching, evaluating, or using the educational apps you selected?