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School district technology awareness: a descriptive study identifying implications for the 21st-century teaching and learning

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SCHOOL DISTRICT TECHNOLOGY AWARENESS: A DESCRIPTIVE STUDY IDENTIFYING IMPLICATIONS FOR THE 21ST- CENTURY TEACHING AND LEARNING

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ABSTRACT

Preparing students for 21st-century learning is a great responsibility and a challenge for many school districts across the country. A large body of research suggests that a school district's level of awareness with regards to education technology and particularly those technologies that are on a positive trend correlates with a successful technology implementation program. District Administrators that lead the charge of developing technology policies and oversee the various aspect of the technology implementation must possess a solid awareness of modern education technologies and their interplays with curriculum and pedagogy. In addition, district Administrators must have the technological skill to overcome network infrastructure capabilities constraints as well as the leadership skill to prioritize technology.

This study used a survey as its main method of data collection; the survey was guided by three research questions that helped gain valuable insight about California K12 school district Administrators' familiarity with most relevant modern technologies and strategies for educating students in the 21st-century, knowledge of intermediation between (technology, pedagogy, curriculum), as well as what Administrators perceive as constraints that impede effective technology implementation. The data shows that majority of district Administrators reported to having insufficient knowledge of modern and emerging technologies or digital strategies that are most reliant on technology, in addition, the data suggest that district Administrators are finding funding, training, and infrastructure as main factors that impede implementation of technology appropriate for a 21st-century education. The results of this study propose recommendations that have implications for K12 school districts' technology awareness, knowledge acquisition for technology preparedness, district technology plan, and minimum technology readiness requirement for school district Administrator positions for the 21st-century.

Chapter 1: Background of the Study

School districts in the U.S. are finding that preparing students for the digital age is a responsibility that needs to be tackled with a comprehensive action plan. The plan that a school district develops for its technology implementation is mostly referred to as a district technology plan, which is written for about 2-5-years. There are many drivers that are instrumental in getting school districts to improve their exposure to technology such as a greater need for computers to assist with facilitation of individualized learning using digital content and smart software and many new curricular and pedagogical shifts that are taking place due to greater demand for advanced uses of technology in the work place. Educators are increasingly finding that immersive media technologies that allow students to interact with and manipulate virtual objects are becoming a necessity for teaching and learning within the context of the latest academic standards such as Common Core State Standards (CCSS) or the Next Generation Science Standards (NGSS) that with every update pushes for greater rigor and depth for learning that can only be done with the use of technology. Students now depend on their mobile devices more than ever before to stay connected with the world and to access information mostly wirelessly via the Internet, which require a more robust district network infrastructure. A thorough examination of current research and how school districts get informed about of technology trends, and how technology implementation impacts curricular and pedagogical practices can help guide how school districts provide for technology, and how districts cope with constraints related to budget, training, infrastructure, and other realities of an ever-changing landscape of teaching and learning with technology.

This study focuses on school district technology leaders and their awareness of current technology trends, their involvement with pedagogical and curricular practices, and challenge related to planning, budgeting, and implementation. About one-third of school districts in California during the 2017 academic year had at least 1000 students enrolled within each district. This study focuses on assessing district Administrators who are primarily district Superintendents, district directors, and site Administrators who are involved to some extent with planning and implementation of technology. The theoretical underpinning of this study relies primarily on current education technology research as well as the ISTE standards, which draws from current and relevant research focused primarily on enabling teaching and learning with technology for the 21st century. Also, the survey tool developed for this study relies on the recommendation from National Education Technology Plan (NETP), and the Technological Pedagogical Content Knowledge (TPACK) framework.

There are thousands of school districts across the U.S.; in California alone, there were 1,204 school districts with 10,477 schools across grades P/K-12 serving 6,228,235 students, according to California Department of Education's (n.d.) statistics for the 2016-2017 school year. The largest 283 school districts in California account for over 80% of the 6,228,235 students that are enrolled in the state. The data obtained in this study sheds light on school districts' level of preparedness to meet the need of digital natives via their awareness of current trends in technology, understanding of the interplay between (technology, pedagogy, curriculum), as well as identification of some challenges related to funding, training, infrastructure with implication on future policy and practice for more effective technology implementation.

The National Education Technology Plan and the technology plan framework by the California Department of Education encourage every school district to develop and implement a relevant technology plan that can meet or exceed suggested baselines for technology readiness and infrastructure. Current state and national guidelines reference ISTE standards as an essential consideration and basis in education technology research for planning, development, and implementation of a school district technology plan that can successfully accommodate the implementation of CCSS, NGSS with a technology implementation framework, such as the TPACK. The ISTE standards suggest that the role of a district technology lead is getting far more complex and require a great deal of awareness of the latest technologies and other skills that relate to leadership, planning, budgeting and implementation within a complex environment that is continually shifting structurally due to changes and the tensions that exist between the various technology initiatives and student needs.

Many school districts are trying to find ways to use technology in the best way possible; however, implementation varies widely for myriad reasons, such as commitment of sufficient resources for technology, staff development and availability of qualified staff, funding or reallocation of funds from other competing priorities, and determining how to best develop an information technology network infrastructure that can support the growing need for technology are just some of the examples. Technology leaders' ability to cope and keep up with challenges that different technology implementations require is another consideration, which can improve district technology implementation and planning. Complacency on the part of district leadership or not having a viable technology plan that is sufficiently robust and scalable can place a school district at great risk of losing student enrollment to other neighboring districts or other competing schools. For example, many online programs and other non-traditional learning opportunities in the P/K-12 space can now easily compete with traditional brick-and-mortar school districts and the encroachment can easily threaten the traditional brick-and-mortar business model and may potentially force restructures that often cause major consolidations or closures of sites or programs due to already existing struggles that districts are facing with federal and state funding. For a modern school district, technology awareness and a clear technology plan are necessities that can play a pivotal role in how the district operates or competes for students in an era of growing competition from pure online and blended learning models of education that allows access to educational resources without being tied to any particular district's geographical boundary.

For this study, a survey was developed to gain insight as to what is the level of district Administrators technology awareness, what do they know about emerging technologies, what is their involvement or understanding of teaching and learning, and what are some constraints that impede technology implementation due to funding, training, and infrastructure. The survey uses critical elements that ISTE has deemed necessary for school districts and technology leaders to consider, so that modern application of technology is more effectively leveraged for learning. These elements can help determine the level of alignment of a school district's technology preparedness and awareness of those that make technology decisions with regard to such factors as the development of a district shared vision, stakeholder access to technology, comprehensive plans for professional development, provisioning and planning for technical assistance and support to educators, implementation of metrics to monitor evidence and the mechanisms for ongoing evaluation of the intermediation between technology and instruction, development and execution of policies that promote student-centered teaching, mechanisms for community support and involvement, and fiscal policies to support technology initiatives that promote teaching and learning. The school district contact information for this study was obtained from the California Department of Education's (n.d.) website, which publishes the most current statistics about each California public school in operation during each school year.

The increased focus nationally by districts on the currently administered CCSS and NGSS assessments provides each school district with an impetus to have adequate technology infrastructure. Preparedness for the state-mandated CCSS and NGSS assessments present both challenges and opportunities for many school districts across the country. It is simply not an easy task for most district technology leaders to use the technology buildup that they are required to make for state assessment readiness as an opportunity to further enhance their technology utilization for non-testing purposes. District technology leaders' familiarity with daily teaching and learning can significantly improve each district's ability to align infrastructure buildup from the testing and quickly leverage and repurpose for their vision of technology; as timely technology integration is extremely vital for the digital age education (Venter & Bezuidenhout, 2008).

ISTE (2016) standards provide school districts a clear technology integration roadmap for an increasingly digital world and offer guidelines for practice and efficient use of technology in education. The National Council for Accreditation of Teacher Education (NCATE, 2010) endorses ISTE standards for teacher preparation through its current accreditation process. Often overlooked is the fact that education is not new to technological innovations; just as once papyrus, paper, chalk, and the overhead projectors were the focus of attention, today tools such as networked digital computers, mobile computing, e-learning, websites, blogs, podcasts, wikis, and social networking are taking the center stage until replaced by some other next generation of technological tools and innovations. Students now have access to a worldwide network of users and information databases of all types, which makes the case that information in and of itself is becoming the primary source of value in society (Castells, 2011). For instance, today access to scientific research depends highly on data that is mostly available online (Beetham & Sharpe, 2013). It is widely evident that the way in which society is evolving with technology is causing a dramatic shift in the way school district staff should interact with technology. For example, teachers may argue that technology does not determine educational practice; however, if learning is deeply rooted in social and cultural contexts, then the adoption of digital tools by educators due to the strong forces from society's adoption of technology will challenge old ways of thinking and influence both pedagogical and curricular activities.

McLuhan and Lapham (1994) argued that the old medium is the content for the new medium until we are challenged to develop new ways of doing things in the new medium. For instance, the initial use of the Internet was limited due to low bandwidth and some rudimentary applications such as email, but now teachers can use the Internet to engage students with an array of collaborative, constructivist transactions that involve a variety of software that uses multi-mediated activities. Specifically, high-speed Internet and more robust network connectivity enable teachers to use valuable learning tools such as rich multimedia experiences, visualizations, and other educational uses for greater collaboration across the globe through social networking, and other mechanisms such as asynchronous and synchronous communication outlets. The use of intelligent tutoring software, virtual laboratories, speech recognition tools, biometrics-authentication, and many other mechanisms for delivering rich lesson content are now possible. The emergence of such technological tools affords students opportunities to engage in more authentic learning experiences with wider community participation that connects a wide range of learners across the globe (Lombardi, 2007). Nevertheless, with all the advances that we have so for experienced, the definitive influence of digital technologies on the various aspects of education has yet to be quantified (Garrison & Anderson, 2000). However, disruptive technologies of today such as e-learning, cloud computing, augmented and virtual reality, and 3D printing, which appears to the potential to fundamentally alter the entire landscape of teaching and learning as we know it (Garrison, 2011). What is widely expected today is that technology is here to stay and its adoption is accelerating at an increasing speed within the various aspects of education, which follows a similar trajectory already evident with the modernization of the society at large with technology adoption.

School districts that want to be future ready with their technology plans can take full advantage of the current education technology research to gain awareness about how and when technology can be implemented to maximize student outcomes, and quickly curtail declining enrollment by keeping teachers' pedagogical practices relevant for today's digital generation. The ISTE standards and the NETP are supported by an extensive body of relevant education technology research and provide the criteria for the evaluation of a school district technology plan and provide a clear roadmap for district technology leaders' level of awareness and readiness. The latest report from New Horizon identifies various education technologies in areas such as consumer electronics, Internet, social media, visualization, and digital strategies to have great significance for teaching and learning, and within each technology domain the report points to specific emerging technologies that will have a great impact on strategies for future planning of education technology implementation that district technology leaders need and the district to be well versed in.

Statement of the Problem

The latest research identifies general trends within the domain of emerging technologies and conditions that must exist within a school district's technology plan that can pose significant challenges for school districts. A large body of research suggest that many of the challenges that districts face is often due to their lack of awareness of technology trends, and how they use technology once they acquire it. Some of the challenges can impede district's ability to achieve improvements in areas of equity, accessibility, and usability of technology. Additional research that identifies (a) district awareness of technology trends, (b) its understanding of a technology implementation framework such as the TPACK, (c) and district Administrators' knowledge of the constraints that impede technology implementation, which can contribute to the body of research that further identifies additional problems or implications that are useful for districts to consider regarding their technology awareness and implementation.

Statement of the Purpose

The purpose of this descriptive research study is to determine the extent to which school districts leadership is aware of relevant 21st century education technologies, modern practices, and relevant policies that conform to the latest education technology research and standards, such as those established by ISTE; this study also examines district technology leaders' familiarity with the intermediation between technology, pedagogy, and curriculum, which is an important consideration for district technology preparation for implementation. Also, this study probes to understand the kinds of constraints, supports, problems, or issues related to policy and practice district Administrators perceive that impacts a district's ability to plan, budget and adopt the technology.

The data from this study can be used to identify potential gaps in current research and establish a baseline from which school districts can guide and improve the effectiveness of their technology implementation. The findings can also be used to provide insight into what roles and responsibilities district technology leaders may play in order to expand or refine their existing district technology plans and to gain strategic advantage in areas of technology planning, policy development, leadership capacity building, development of strategies for professional development, and prioritization of district resources for a more effective technology implementation and utilization.

Research Questions

The survey process aims to address the following research questions:

1. How aware is the district technology leadership with the trends in current technology?
2. How aware is the district technology leaders of the intermediation between technology, pedagogy and curriculum?
3. What constraints, supports, problems, or issues related to policy and practice does the district technology leaders perceive that will affect district's ability to plan, budget and adopt technology?

Methodological Overview

The theoretical framework for the development of the survey tool used in this study is based on an extensive review of the latest literature, with a focus on the 21st-century learning that explores trends in emerging technologies and school districts' constraints with regards to such factors as funding, planning, implementation, policy, and practice. This descriptive research study uses a convenience sampling method designed to examine technology awareness of district technology with current technology trends and uses of emerging technologies for curricular and pedagogical practices, as well as roles and responsibilities that district leadership undertakes with regards to planning, budgeting, and implementation of technology. The survey is guided by latest research, as well as recommendations found in the latest release of the 2016 ISTE standards, the latest New Media Consortium (NMC) Horizon Report, and the 2016 updated U.S. Department of Education's NETP. The development of the survey is further guided by the essential conditions that are recommended by the ISTE 2016 standards, as well as recommendations from the 2016 NETP plan, and other research on technology planning and implementation. Additionally, the NMC's Horizon Report has influenced the survey questions regarding technology awareness concerning emerging technologies that are relevant in 2017 and should be considered for teaching and learning. The scope of this study is limited to California school districts with the student population of least 5000 students that serve grades from preschool to 12th grade.

Definition of Terms

Emerging Technologies: technologies that are in the early stage of adoption (Cervone, 2015).

3D Printing: process used to create a three dimensional object by using various materials layer by layer, 3D printing is also known as additive manufacturing (McMenamin, Quayle, McHenry, & Adams, 2014).

Adaptive Learning: is an educational method, which uses software to continuously customize and mediate resources according to the individual need of each user (Steichen, Carenini, & Conati, 2013).

Artificial Intelligence: artificial Intelligence is a simulation of human type intelligence by software or machines (Timms, 2016).

Augmented Reality: computer generated images like graphics or GPS data are superimposed on real-world environments to create an augmented realty (Billinghurst & Duenser, 2012).

BYOD: bring your own device to use in a computing environment (Song, 2014).

Cloud Computing: an information technology paradigm refers to enabling technologies to access shared pools of computing resources over the Internet (Mell & Grance, 2011).

Coding: coding makes it possible to create software applications for computing purposes (Rubinstein & Chor, 2014).

Crowdsourcing: it is a process of getting people over the Internet to fund or solve a problem (Porcello & His, 2013).

Digital Badges: digital badges are used to validate accomplishment for different online participation (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2015).

Flipped Classrooms: it is an instructional strategy used to reverse the traditional learning environment by delivering most of the instructional content online, and allowing students to do their traditional homework assignments in class (Lo & Hew, 2017).

Internet of Things: it is a network of physical devices like appliances that are embedded with electronics and software that can be connected with each other and exchange data (Castells, 2011).

Machine Learning: it is the ability for computers to learn without explicit programing (Michalski, Carbonell, & Mitchell, 2013).

Online Learning: it is also referred to E-Learning a method of acquiring knowledge using an online network or the Internet (Picciano & Seaman, 2010).

Open Hardware: refers to hardware design specifications that are published and can be created, modified or distributed by others (Mondada et al., 2017).

Virtual Reality: it is a three-dimensional simulated image or environment that can be interacted with (Glanz, Rizzo, & Grapp, 2003).

Wearable Devices: item of technology that can be put on clothing or body (ISTE, 2016).

LMS: it is a learning management system that allows for distribution and management of online learning (ISTE, 2016)

Computational Thinking: it refers to the thought processes that involve methods or instructions that a computer or machine can carry out logically (Bers, 2010).

Digital Citizenship: Activities that involve information technology to engage in society for various reasons (Ribble, 2015).

Curation: it refers to digital perseveration, handling, processing and manage of online content (Beagrie, 2008).

Blended Learning: blended learning is a educational methodology that involves formal and informal learning where both online and classroom instruction is used in some proportion (Anohah, Oyelere, & Suhonen, 2017).

Maker Movement: is an umbrella term used to included independent inventors, designers and thinkers (Halverson & Sheridan, 2014).

Assumptions, Limitations, and Delimitations

Assumptions: It is assumed that survey respondents are accurately completing the survey questions; as the survey asks for respondents to reveal their weaknesses or strengths in some of the questions. Limitations: The survey may be limited in gaining exact geographic scope of participants. The minimum size of student population per district has limited the results to mostly medium to large sized school districts in California. Some respondents may find the number of questions on the survey to be too many or time-consuming, which may impact their participation consistency throughout the sections. Delimitation: California school districts with the student population of mostly over 5000 students were surveyed. District technology leaders include Superintendents, IT Directors, Education Technology Directors, Site Principals, and other District Technology Leaders. At most 978 school districts were contacted to participate, of which 272 districts participated.

Chapter Summary

As technology plays an important part in helping school districts enhance their offers for the digital age students, school districts need to consider technology implementation strategies that can help improve their ability to improve their district operations with regards to implementation. There is a wide body of research that proposes important considerations for school districts to meet the need of their 21st-century students.   The purpose of this descriptive research study is to determine the extent to which school districts leadership is aware of relevant 21st century education technologies, modern practices, and relevant policies that conform to the latest education technology research and standards, such as those established by ISTE; this study also examines district technology leaders' familiarity with the intermediation between technology, pedagogy, and curriculum, which is an important consideration for district technology preparation for implementation. Also, this study probes to understand the kinds of constraints, supports, problems, or issues related to policy and practice districts perceive that impacts a district's ability to plan, budget and adopt the technology. The theoretical foundation for this study is based on an extensive body of research that identifies trends within the domain of emerging technologies and conditions that must exist within a school district for successful implementation of technology. The data from this study can be used to identify potential gaps in current research and establish a baseline from which school districts can guide and improve the effectiveness of their technology implementation.   The survey for this study is guided by latest research, as well as recommendations found in the latest release of the 2016 ISTE standards, the latest New Media Consortium (NMC) Horizon Report, and the 2016 updated U.S. Department of Education's NETP. Additionally, the NMC's Horizon Report has influenced the survey questions regarding technology awareness concerning emerging technologies that are relevant in 2017 and should be considered for teaching and learning. The scope of this study is limited to California school districts with the student population at least 1000 within a wide range of demographics.

Chapter 2: Review of the Literature

It is widely acknowledged that the use of technology can greatly enhance many educational initiatives, individual student potential while giving teachers more options to harness affordances of different technologies. Use educational technology strategies that leverage such things as cloud computing, makerspace, mobile learning, 3D printing/rapid prototyping, intelligent software, information analytics and visualization, digital badges/microcredits, computational thinking, coding, wearables, and many other technology strategies seems to be changing both teaching and learning with increasing speed. School districts have the intent to engage their teachers with regards to their technology integration initiatives. However, building teacher capacity in uses of education technology through policy and practice cannot be done arbitrarily or without a well-engineered plan. It is known that districts often attempt to get teacher buy-in for many of their initiatives through pilots, demos or some internal assessment such as a survey; however, technology implementation cannot just be narrowed to meet the need of just a few that participate in some survey. Technology readiness assessments or other formal means can be useful in helping districts gain situational awareness and to establish a baseline for prioritization of resources to include all teachers at their individual level. Often districts do not have the resources to act on the information that they gather because of other competing priorities or other fiscal related constraints. In recent years there have been many discussions within academic circles and education technology conferences about how school districts need to orient their focus towards new digital strategies or technologies such as computational thinking, digital literacy, gamification, augmented reality, virtual reality, 3D printing, cloud computing, and online learning. New technologies are emerging at an increasing rate, and research suggests that teacher success highly depends on a school district's ability to keep up with their awareness of what is trending with technology, and what type of technology implementation strategies is best for their use. Additionally, every new technology requires that districts commit to providing high-quality training and continuous support for its staff.

Education Technology for the 21st Century

The emergence of newer technologies continues to transform the landscape of education; therefore, it is important that districts realize that they need to develop their abilities to rapidly test, adopt and get ready for the next innovation to be used for solving pedagogical or curricular problems that would advance teaching and learn for the digital age. District technology leaders such as an IT director can greatly benefit by knowing what the current education technology trends are to benefit the curricular and pedagogical applications.

In 2017 there were many technologies and digital strategies that are being discussed. Computational thinking and digital literacy are commonly used terms in many education technology circles. Computational thinking refers to algorithmic thinking or a step by step mental processes that involve many levels of abstractions in devising problems and solutions in such a way that an information-processing agent like a computer software can use as instructions to produce an output (Wing, 2006). Lately, many school districts have been trying to instruct students to learn computational thinking via basic computer programming courses at their schools due to increase in discourse about the topic within many academic circles, which promise to give students an extra set of tools to solve problems and design useful systems that rely on simple to complex algorithmic processes. Opportunities for computational thinking lessons seem to be emerging everywhere, including in biology, economics, engineering, and even in the arts and humanities (Astrachan, Hambrusch, Peckham, & Settle, 2009; Denning, 2009; Rubinstein & Chor, 2014; Wing, 2006). As we continue to drown in data, computational thinking will become more useful for the development of computational processes and techniques that can make sense of the vast amounts of information that continues to pile up, and it will be instrumental to paving new paths, leading to discoveries or innovations. For students to succeed in modern society, they must be exposed to some level of computational thinking within their academic context (Wing, 2008). Thus, according to current technology trends and trajectory, school districts can greatly benefit their students when they introduce them to computational thinking and make computational thinking an integral part of their teachers' practice.

Today districts are discovering that their students are preparing for jobs of the future, many of which will require coding skills, and it is important that district technology leaders gain that awareness and understand the importance to push for greater implementation. For example, in 2017 emerging topics such as nano-computing, bio-computing, quantum computing, and so many other new topics that assist with handling of data are now appearing as a topic of discussion in many academic circles and are tickling in the newer textbooks, which serve as drivers that are pushing for greater student exposure to computational thinking and digital literacy for many school districts to start getting ready and prepare their technology infrastructure to accommodate the increase in demand. Young children as early as Pre-K are exposed to curricular material that expects them to construct objects using known design processes that professional engineers use; in many cases young children are given opportunities to interact with robotics and complex systems with interacting parts in most cases; these types of engagements require following one or more sets of logical instructions such as those taught in computational thinking (Bers, 2010). Professional development (PD) will allow teachers to engage in conversations with peers for greater exposure to new ideas and to witness best practices for gaining confidence in starting their journey towards the integrate computational thinking into their daily practice and improve their readiness for requirements of the various emerging academic topics such as coding. Today there is a growing number of school districts that partner with organizations as Code.org to start their first computer programming courses; for instance, the Code.org model allows teachers to work with other teachers across other districts in the country to facilitate collaboration and access to relevant computer science curricular material, which can support different academic goals (Kalelioğlu, 2015). It is also commonly known today that many districts are piloting coding curriculums such as Google’s CS First at their elementary schools to help students obtain experience with coding via child-friendly and relatively easy to use coding platforms like Scratch, ScratchJr, or Snap! (Resnick et al., 2009). In 2017 many educators see coding as a viable emerging new literacy and software such as ScratchJr from Massachusetts Institute of Technology or Snap! from UC Berkeley offers the potential to allow teachers to expose young students to programming via interactive stories and to engage them with new academic topics that require computational thinking (Prensky, 2008).

It is widely known that digital natives tend to get bored easily with outdated pedagogical practices of yesteryears. District leader’s knowledge of what digital natives prefer to learn with or from can greatly improve student retention rates and improve the overall academic performance and engagement. Making learning fun is one of the top priorities for most teachers who want to achieve better student outcomes (Huang & Soman, 2013). There is evidence to suggest that many teachers do try to incorporate such things as gameplay into their daily lesson plans within different curricular context (Takeuchi & Vaala, 2014), some studies show that gaming increases student engagement and provides students with a variety of physiological benefits (McGonigal, 2011). For example, chemicals that gaming stimulates in the brain such as epinephrine, dopamine, and norepinephrine promote positive feelings and make users more eager to learn (Gutierrez, 2012). Many researchers would agree that many academic subjects such as mathematics, science, and social studies would benefit greatly from the integration of gaming activities that have the potential to develop problem-solving abilities, spatial thinking, and decision-making, all of which can potentially improve student outcomes. District technology leadership's understanding of computer games that can provide an alternative to usually mundane lectures and paper worksheets would spark more interest across the district from both teaching and learn prospective; with the understanding that gaming would provide for more ways to engage learners through goal-oriented mechanisms that gaming can provide (Rahn, 2009). Today, district technology leaders can get involved by supporting provisioning of a district network infrastructure that can support a more robust bandwidth that gaming requires for teachers to confidently start gamifying some of their lessons, which would eventually pave the path for greater integration across different curricular activities and subjects. Teachers can take full advantage of educational affordances of different gaming genres; for instance, games provide goals that students can pursue, challenges that can range in level of difficulty and customizations that will allow students to personalize their experience, while teachers monitor clear progression to mastery through the real-time feedback that many gaming platforms offer. The social engagement, meaningful rewards, visible status, control of levels, autonomous decision making, tools to express oneself, switching roles, and a host of other opportunities for the students and teachers make gaming a worthwhile pursuit (Huang & Soman, 2013). Today, gaming is one opportunity that continues to improve with advancement in software and hardware each year, based on the results of several empirical studies, the effect of game elements on education remains somewhat unknown; however, many recent studies suggest that gamification has the potential to improve learning if used correctly (Dicheva, Dichev, Agre, & Angelova, 2015). Advanced gaming platforms that use technology-mediated simulations, will allow students to reflect on and discover the intersection between their real-world identities and virtual or game identities; as such, their virtual identities can be leveraged to help shape their real-world identities (Gee, 2003). For instance, today's technology leaders can introduce teachers to gaming technologies through some relatively easy to access software, like Microsoft's Minecraft, to start the process of experimenting integration of gaming with their teaching within such topics as science, mathematics or social studies. This will allow for simulating places, systems, and structures to tell stories or improve understandings of complex events and sequences; as many lessons will greatly benefit from affordances that gaming provides through collaboration using virtual models while keeping the level of academic rigor and learner engagement at a very high level, which can go far beyond what was traditionally possible through many classical or non-digital means (Short, 2012). School districts' understanding of what the current gamification technology trends are, and what is appropriate for their curricular application can greatly improve the integration process of gaming for all students and teachers.

Other technologies that are starting to get attention in many academic circles such as augmented reality (AR) have improved vastly during the early part of the 21st century and more specifically from 2013 to 2017. Augmented reality is an example of a technology that wasn't well known five years ago, but today it is emerging as one of those technologies that can take hold and substantially transform teaching and learning. Researchers understood years back from 2017 that technologies such as AR would allow for projection of digital materials onto real-world objects someday and would provide learning opportunities in ways that were not possible before (Azuma, 1997). It is important for district technology leaders to develop awareness of what opportunities emerging technologies, like AR, can offer and how it can be appropriately used for modernization of pedagogical practices with technology. Technology such as AR allows students to imagine the world through a virtual overlay that opens another dimension and extends the capabilities of another known emerging technology called virtual reality (VR), which is capable of completely immersing the user's senses in an artificial environment. Students can experience learning by overlaying objects that will coexist within the real-world environment and may include text, animation, images, videos, sound, and 3D models. A large body of research suggests that AR type technologies have enormous potential in the future as computing capabilities continue to get better and that AR can improve teaching methodologies and learning outcomes (Bower, Howe, McCredie, Robinson, & Grover, 2014). For example, today one benefit of AR for teachers is that it allows for the rescaling of virtual objects from molecules to planets, which affords students the ability to manipulate and make sense of concepts that otherwise would have been difficult to grasp (Johnson, Adams, & Cummins, 2010). Significant barriers such as time and technical skills for the implementation of AR can be resolved if the district first understands what the technology is used for and then provide the means for technical support or training for teachers through a well-researched framework to facilitate better technology integration with curricular and pedagogical activities at its core (Billinghurst & Duenser, 2012). Many emerging technologies such as AR are complex; therefore, users will gain more confidence during the process of integration if they receive insights from district leadership and have access to other users through opportunities that the school district can facilitate for collaboration. District technology leaders' understanding of the complexities and uses of the different technologies such as AR will help greatly with the planning, implementation, support, and training for the implementation. With any new technology, such as

AR, lesson demonstrations by master teachers that are coupled with observations of what teachers can relate to within their specific curricular application can have a profound impact on the adoption process. Today, with technology such as AR, teachers will be able to provide their students with access to contextually relevant multimedia experiences that many 21st-century curricular activities require.

Another technology that has picked up traction in education since 2015 is Virtual Reality(VR) enabling technologies. VR type technologies, use image processing, graphics rendering, and multimedia technologies (Knott, 2000). Like most other emerging technologies, VR has increasingly become more affordable and has overcome many of its limitations tied to hardware, software and the cost. For instance, significant improvement in computer processing and display technologies have led to dramatic increases in research and development in related technologies that can continually improve the infrastructure, hardware, and software that a technology such as VR continues to dependent on (Glanz et al., 2003). Many emerging technologies can quickly mature, for example, high definition simulations through VR is now possible that can add tremendous value with significant implications for many curricular applications in education (Johari, 2005; Saleeb & Dafoulas, 2011; Wasson, 1997). A virtual classroom can be held in cyberspace and offer advanced features that are nearly impossible to achieve within the traditional classroom settings. Support for integration of VR type technologies within many curricular activities has also come a long way for educators due to advances in Internet bandwidth, software, the computer processor, and hardware capabilities. Consequently, district awareness that VR can be used for such uses as conducting virtual laboratory experiments, provide distance learning, or help students with technical training virtually can position the district to take advantage of such technology better to further their educational offerings. Through an extensive meta-analysis of various recent research studies, Merchant, Goetz, Cifuentes, Keeney-Kennicutt, and Davis (2014) found that VR is highly effective in making content more accessible and fun. As it is commonly known, the price performance of technology nearly doubles each year. Just five years ago, the cost of a rudimentary VR system was highly prohibitive; however, in recent years, the increasing popularity of related innovative products such as Google Cardboard VR, Oculus Rift, and HTC Vive have made adoption of VR more affordable, and there is more incentive for districts to consider integration of VR into their instructional practices (Choi & Varian, 2012). Technology, like VR, seems to have enormous potential today and have been shown to improve cognitive skills as well as access to certain curricular activities that only such technology can provide. For instance, this type of technology is allowing students to build 3D objects or tackle abstract concepts with different subjects (Merchant et al., 2014). For example, students in a biology class can see how a beating heart looks like the inside of the human body, or how tiny electrons move within an electrical circuit. Studies show that teachers can use VR to teach abstract concepts in science, mathematics, and other subjects via virtual encounters that are typically outside of the normal human experience (McGrath, Wegener, McIntyre, Savage, & Williamson, 2010).

Today, other technologies such as 3D printing come with the promise of revolutionizing the manufacturing industry by creating durable and safe products in large quantities using digital information to make physical objects; the printers are quickly becoming more useful and could be used in new ways that can impact our everyday life. It appears that the technologies that are associated with the 3D printing will play a key role in starting the next industrial revolution (Nov, Arazy, & Anderson, 2011). Educator’s awareness of 3D printing presents opportunities and potential for pedagogical practices that weren’t possible just a few years ago. Today, students can use the additive manufacturing process or 3D printing that involves fusing one layer of a printing material at a time to make a 3D object; the process is usually controlled by a design software such as Autodesk's Computer Aided Design (CAD) software. Within the past three years there has been a noticeable increase in the number of 3D printers across many school districts; today it is not difficult to find at least one teacher on every campus that has given 3D printing a try or have heard of it. Teachers that have a 3D printer are often happy to show off their students' work; often students tackle more complex and innovative printing jobs as both the students and their teachers gain experience with the process of printing and experiment with new materials and design concepts. It is important for districts to know that this type of technology is accessible today, and it allows for students to be engaged in hands-on problem-based learning while they wrestle with concepts that are connected directly to the curriculum (Gershenfeld, 2005; Martinez & Stager, 2014).

Teachers are now seeing greater implications for technologies like 3D printing in the new academic standards: specifically, this type of technology today allows for, printing such objects as prosthetic limbs, custom-made musical instruments, and machinery parts that can help teachers deliver more effective lessons where their students can gain a better understanding of concepts they are learning. The 3D printing technology continues to mature, and the range of possible uses for this type of technology is promising; today, multiple materials can be used to print such items as cells and tissues, giving educators myriad opportunities in this new revolutionary dimension that wasn't imaginable just one decade ago (McMenamin, Quayle, McHenry, & Adams, 2014).

District awareness of the new generation of learners who are also referred to as digital natives is important because these students have already adapted to tremendous connectivity and collaboration with their computing devices like their cell phones. Papert, Tyack, and Cuban (1997) argued that social penetration of communication and information technologies can help teachers develop new ways of educating their students, and a technology such as 3D printing can just do that by giving students the opportunity to invent and innovate, as their growth remains rooted in their experience (Papert, 1993). It is also good news for teachers that there is broad availability of open source materials for popular technologies such as 3D printing, which can enhance the application of the technology and improve student outcomes by giving students and teachers more opportunities to experiment with and learn using the technology (Benkler, 2006). A district can provide more opportunities through district technology plans to further teachers' knowledge of technologies such as 3D printing and highlight the curricular and pedagogical implications for their practice. Reduction in cost and improvement of 3D printing technologies is expected to increase utilization across different subject areas such as math and science; the makerspace movement is also picking up momentum in many school libraries and media centers where the 3D printers seem to serve as one of the main focal points.

Today there is a great push by many school districts to reduce the digital divide and equip teachers with as many technologies and training as possible. For example, one such technology that is often mentioned involves cloud computing tools that offer the potential to improve efficiency, scalability, and reliability of software deployment within existing hardware resources (Kurbel, 2001). Cloud computing enables ubiquitous, easy, on-demand network access, which allows for shared and customizable computing and academic resources (Mell & Grance, 2011). Today, many curricular activities are encouraging teachers to use virtualized resources and software to increase productivity, access, and real-time collaboration. Districts can plan to use today's available cloud services such as Google Apps for Education (GAFE), Office 365 from

Microsoft, and many other to enable their teachers, students, and staff with tools while substantially reducing deployment time and expenditure. Today, big players that offer cloud services like Google, Amazon, Microsoft, and Adobe are pushing for modernization of data centers that includes greater virtualization of IT infrastructures and more implementation of subscription-based cloud software; the general growth trend for cloud technologies adoption seems to be on a positive trajectory (Johnson, Adams Becker, Cummins, & Estrada, 2012). IT directors' awareness of the various cloud services for education can well-position the district to leverage the technology to meet specific district objectives.

Today many teachers are already familiar with or have heard about such technologies as e-learning, video streaming, and systems or objects simulations; cloud computing technologies are known to improve access to those opportunities for teachers so teachers can provide better educational experiences for their students (González-Martínez, Bote-Lorenzo, Gómez-Sánchez, & Cano-Parra, 2015). District awareness and plan that includes ongoing teacher development and support for cloud services will allow better implementation and efficient dissemination and use of digital curricular materials for the classroom.

School districts would greatly benefit from exploration to find as many technology opportunities that fit their context. Technologies that are enabling online learning is helping to expand and shape district offerings in response to the growing demand for hybrid and virtual learning from those students and parents that require the flexibility of access without being bound to space or time (R. Cole, 2000). Today, technologies that enable blended learning and fully online instruction are experiencing a surge in demand as Internet connectivity, and software advancement continues to improve; it is often the case when technologies that appear to provide opportunities continue to be in demand in education (Volery & Lord, 2000). Many districts are now realizing that keeping their services confined to obsolete strategies of past years such as keeping the 100% brick-and-mortar model may not be a viable strategy for the future. For example, today a considerable percentage of students are already participating in homeschooling programs across the nation, where instruction is delivered through a hybrid model as some or most of the instruction is delivered using some form of a modern technology strategy. Hybrid and online models of today rely heavily on Learning Management Software (LMS) technologies such as Moodle, Schoology, Canvas, Blackboard and many others, which allow for online lesson delivery, assessment management and implementation through synchronous and asynchronous communication with the students. Furthermore, other features of the LMS allow for educators to collect student data and to personalized learning. In recent years, there has been a notable and study increase in the percentage of high school instruction that is offered online (Christensen & Horn, 2008). Due to the rapid expansion of network bandwidth, Internet speed, and advances with cloud software it is expected that the percentage of students in the P/K-12 space that are receiving online instruction will continue to increase (Picciano & Seaman, 2010). As these online programs continue to grow, school districts' technology plans must be aware of such trends to meet their teachers' need for training so that the district can continue to expand their offerings and improve learning experiences for their students through technologies such as an LMS of their choice or other software that can facilitate their online initiatives. District would benefit if its technology leaders and staff take part in planning with teachers, so they are always involved and can help determine the scope of technology support for the teachers, while teachers should be given the opportunity to collaborate and figure out the appropriate level of blended instruction and how the lessons can be made ready with some of the today's popular software like Moodle, Schoology, or Canvas that are designed to manage online content and delivery.

Furthermore, the district will gain knowledge from teachers' input and their leaderships' involvement of how the topic of online learning will impact its operation; such awareness will also help with clarification of some challenges that involve meditation between technology, pedagogy, and curricular activities. Each emerging and established technology have features or characteristics that can influence or shape the pedagogical moves teachers can make and affects the nature of the content that can be represented, created, or shared within various curricular contexts. District's technology department and its intimate involvement with the district technology plan that specifies the use of each technology and related support and training for the teachers would ensure that a reasonable set of considerations are in place for each technology that the district uses.

Today, school districts around the nation are in a race to increase technology utilization due to many drivers. In recent years' government policy related to E-Rate funding and the, Every Student Succeeds Act (ESSA) of 2015 is supporting school districts' initiatives to align their educational programs to meet the 21st-century academic content standards such as the Common Core State Standards. According to the World Economic Form (2016), 65% of grade school students will work in careers that are not yet been invented, and the Institute for the Future (IFTF, 2014) asserts that future drivers in health, agriculture, security, infrastructure, manufacturing, retail, and media will create new classes of jobs such as data nurses, soil programmers, pre-crime analysts, smart-grid debuggers, bionic tailors, gut florists, and rationality technicians, to name just a few. Many districts are now realizing that survival of a school district will most likely hinge on their robust technology strategies that can support many of the emerging careers that are on the horizon for not too distant future.

There are several established standards for technology implementation. Districts' awareness of standards for technology can help guide planning and implementation of technology appropriately within the context of district's curricular and pedagogical initiatives. It is commonly known today that district is seeking greater engagement with technologies that deliver a more individualized learning experience to empower their students. Through research-based technology implementation standards such as ISTE and a framework like TPACK, districts will have a better chance of appropriately integrating technologies that can empower their students and help prepare them for a future that requires citizens to be technologically savvy. ISTE standards were developed using established practice within the field of education technology that is grounded in extensive research and input from a wide range of experts and practitioners. The development process of the ISTE standards mirrors the process used by the Council for Accreditation of Educators Preparation (CAEP), the American Library Association (ALA), the National Board for Professional Teaching Standards, and others in the field (ISTE, 2016).

District technology leader's understanding of the interplay between content, pedagogy, and technology can play a critical role in helping to shape district's direction with regards to technology implementation. It will not be easy for school districts to eliminate the isolation of content, pedagogy, and technology from the practice of teaching and suddenly divert attention to mediation among these different domains of knowledge, as there are complexities within each knowledge component as well as within the relationships, tensions, or interdependencies with one another (Graham, 2011). Through a systematic and planned effort by the district, it will be possible to guide each teacher toward achieving a dynamic equilibrium with the three domains of knowledge, as each knowledge area (content, pedagogy, and technology) will have a role to play individually as well as together (Herring, Mishra, & Koehler, 2014). A district technology plan needs to account for the fact that changes in practice will require serious leadership, continuous collaboration, ongoing monitoring, and a great deal of effort by all the stakeholders. According to Herring et al. (2014), it is difficult to integrate technology into teaching because of the ill-structured nature of teaching and learning itself. J. Gibson (1977) reiterates that each technology has its specific affordances and constraints, suggesting that teachers must understand where and when to integrate a technology; and district technology leaders' awareness of content and pedagogy can significantly help the district remove some of the constraints and make integration of each type of technology easier and more relevant.

This study has examined the data gathered from 189 school districts to gain an overall perspective of districts' technology leadership's awareness of current technology trends that help shape a school district's technology vision and plan for technology implementation. The analysis of this study is guided by current education technology research including the ISTE standards, which promises a well-researched technology integration methodology for a 21st-century school district that continually strives to close achievement gaps with consideration to equity, personalize learning, and greater access to technology. Analysis of this study is further grounded by research that suggests incorporating a framework such as TPACK can greatly help teachers understand technology intermediation with pedagogy and content according to (Herring et al., 2014). The TPACK framework builds on Lee Shulman's (1987) construct of pedagogical content knowledge (PCK), extending the research by Mishra and Koehler to allow for technology knowledge (Herring et al., 2014). This framework allows teachers and school administrators to think and to learn about the interplay of their knowledge of pedagogy, content, and technology with their teaching practice, and more specifically how to integrate technology into the practice of teaching appropriately (Mishra & Koehler, 2006). District awareness that a technology plan should be based on promoting good teaching that follows recent research methodologies is important; good teaching is not necessarily measured by how much pedagogy one knows, the amount of content knowledge one possesses, or how much one understands about technology, but rather by how the three domains of knowledge correctly interact with one another to become useful in practice of teaching by individual learners. The three areas of knowledge (content, pedagogy, technology) are constantly overlapping by mediation amongst each other, and the intersection of what is being mediated forms that overlap called technology, pedagogy, and content knowledge or TPACK (Herring et al., 2014; Mishra & Koehler, 2006).

Districts need to also acknowledge through their policy and practice consideration that accounts for social and contextual effects that are present and will continue to challenge teaching and learning (Lave, 1996). Learning is socially constructed (Lave & Wenger, 1991); knowledge is distributed over symbolic and physical environments as well as people (M. Cole & Engeström, 1993; Lave, 1988). According to Lave (1993a), there is no such thing as learning, but rather it is changing participation in culturally designed settings, suggesting that learning does not occur in a vacuum through some random transfer, but rather through a change in participation; this is an important consideration for district technology plan development, so districts always keep the social and contextual effects that relate to technology integration in mind. This notion implies that teachers cannot remain in isolation but instead need to collaborate and interact with one another. For instance, district technology leaders would benefit teachers by facilitating a network of interpersonal relations that teachers can use and through which they can share information and learn from one another. The technology plan should also account for instances where teachers are loosely networked and facilitate opportunities for teachers to share resources and act as a community of learners. The technology plan should push for wider engagement, e.g., through popular education technology conferences like the Computer User Educator (CUE) or ISTE so that teachers meet peers from other school districts and can engage in activities to improve their professional practice. Good teaching for the digital learners happens when teachers start to understand the mediation among content, pedagogy, and technology (Koehler & Mishra, 2009).

Figure 1 shows the intermediation among the TPACK components: content knowledge (CK), pedagogical knowledge (PK), technology knowledge (TK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technology, pedagogy, and content knowledge (TPCK), which is described and illustrated by Koehler and Mishra. Content knowledge refers to teachers' understanding of the subject matter, pedagogical knowledge refers to teachers' knowledge of instructional methods and strategies, and technology knowledge refers to teachers' understanding of using technologies for a specific content domain (Koehler, Mishra, Kereluik, Shin, & Graham, 2014). PCK describes the mutually mediating influence of pedagogy on content, and content on pedagogy (Polin & Moe, 2015). TCK refers to teachers' understanding of how they would use technologies appropriately with a specific domain of content. TPK refers to what technology affords and limits for the teaching process.

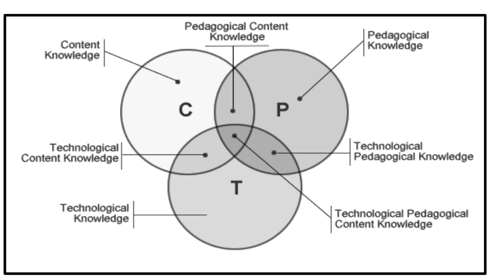

Figure 1. The TPACK framework and its knowledge components.
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It is a district leadership responsibility to fully understand that using the TPACK framework will allow teachers to better think about mediation among the three domains of knowledge every time they plan a lesson in conjunction with an education technology standard such as ISTE. District leadership needs to also understand that none of the TPACK components can be developed in isolation or by itself; however, strengthening each part and placing focus on where it is needed most can help facilitate greater opportunities to develop district-wide practices and policies for training. Every student and teacher experience about learning is unique to the context in which it is learned (Lave & Wenger, 1991); therefore, learning entails creating meaning from real activities and is attributed to a sociocultural phenomenon (Vygotsky, 1978). School districts must provide for policies that explicitly call for professional learning lessons for its teachers that are embedded within the context of what teachers are practicing in the real world. Furthermore, districts should realize that providing opportunities for teachers to live lessons in the context of real-world challenges is where both students and teachers can benefit the most; all teaching activities and those that are designed for teachers will achieve better results when the district considers policies that facilitate the making of each lesson situated, where thoughts and actions are all focused in one area (Lave & Wenger, 1991).

District technology leaders must also seek ways to create opportunities for teachers to start a strong community of learners that provides the setting for the social interaction that affords teachers the chance to reflect on the meaning of the experience of their work and the opportunity to create repositories of shared knowledge (Lave & Wenger, 1991; Williamson, Squire, Halverson, & Gee 2005). The interaction among the district teachers can eventually evolve to become a community of practice over some period, and district technology polices that promote the use of communication technology tools can help further facilitate the process. A district technology plan should provide for the teachers the mechanisms to be able to easily find ways to collaborate and share knowledge both online and offline. According to Lave (1988), learning takes place through dialogue with others in the community; the technology plan should treat each teacher as a learner immersed in the instructional process, which will consist of their learning of instructional content, context, community, and strong participation in their practice. For instance, the technology policy should promote greater hands-on activities for all teacher participants, as teachers will acquire knowledge by conducting situated observations, as described by Lave (1997) to first see others' successfully practice what they are about to undertake for themselves and practice afterward within their context.

The perspective of situated learning theory, which emphasizes that learning is not acquired independently of what the learner's daily life involves and that engagement and reflective thinking will be a part of the process will help the district envision a more robust technology policy; through which teachers will most likely start engaging with technologies that are more situated for their need and can help facilitate better overall outcomes for their students. The need for teachers to integrate technology (man-made tools) has largely existed in the past; however, today that demand is greater than ever before due to continuous and rapid advancements in technology. Therefore, a focused implementation of specific technologies for targeted curricular and pedagogical activities should be a key component of district practice and training for its teachers that would pave the way for greater technology utilization and remove some of the barriers.

Creating Conditions for Teaching and Learning with Technology

It is commonly known that most districts are striving to create the right conditions that facilitate teaching and learning so their students can reach their ultimate potential. District awareness of current technology trends and emerging technologies can help the district create conditions that are required for learning in this digital age, and use the various technologies available by using standards such as the ISTE, which provides a research-based framework that revolves around student learning with technology to empower students so students can take full charge of their learning with pedagogical strategies for teachers that are conducive to the digital age application of technology for teaching and learning (ISTE, 2016). Current content standards such as the most recent iteration of CCSS and the NGSS require teachers to better engage their students with more rigorous cognitive strategies within the content knowledge, learning skills, and techniques towards gaining mastery of the subject, which is essentially the key components of curriculums that prepare students for college and careers (Conley, 2014). For instance, thinking skills that aim to enhance student cognition are built throughout the ISTE standards, allowing teachers to create lesson plans that encourage their students to hypothesize, strategize, identify pathways to solving problems, collect data, analyze research, evaluate outcomes, organize processes, construct models, monitor dynamic changes, and confirm and analyze results during instruction (ISTE, 2016). ISTE standards are frequently updated, and with each iteration, the standards evolve and try to account for the most current trends and research in education technology, as the recent standards reflect a push for network learning and connectivism that are important topics in many academic circles today. ISTE also considers the importance of timely and relevant pedagogical practices such as, independent inquiry, online learning, virtual schools, and blended learning that can open new possibilities for the districts and the learners (Drexler, 2010). ISTE standards help educators provide a framework that places technology at its center with personalized learning opportunities for their students, so students have the chance to take charge of their learning (Attwell, 2007; Aviram, Ronen, Somekh, Winer, & Sarid, 2008). For instance, teachers can use the emergence of computer-mediated adaptive learning systems with intelligent tutors to augment or replace some or most of their direct instruction, according to Enyedy (2014), and the ISTE standards raises awareness of such tools for educators so they can take full advantage of such cutting-edge pedagogical shifts with technology to improve their teaching with technology and give their students more control of their learning. ISTE standards also recognize that teaching is not just about preparing students for a standardized test, but in the bigger picture, teachers strive continually to improve student motivation and nourish mindsets to develop student agency, which is vital in deepening students' connection with their learning and overall academic endeavors (Ferguson, Rowley, & Friedlander, 2015).

Districts need to increase their awareness of as many modern education technology strategies as possible, according to Freeland (2014), competency-based education and blended learning are emerging as an important consideration for districts. Blending learning and competency-based education complement one another, as online content provides students flexibility, especially regarding time, space, and pacing, which provide opportunities for more granular control of an individualized learning environment to improve social utility and the overall implementation of instruction. Gerstein (2016) suggested that necessary conditions for learning that promote learner autonomy and self-determination give learners a context for what they are learning, which help promote confidence, a clear sense of direction that can greatly improve academic results. Districts should develop polices to help teachers develop autonomous and responsible learners through motivation with appropriate technologies that can improve access and personalization, which will lead to greater inquiry-based learning and student interest (McCombs, 2012). Furthermore, students that are given tools and opportunities to be more in control of their learning through whatever means tend to be more successful (Metcalfe, 2009).

According to Tullis and Benjamin (2011), learners that are allowed to self-pace their learning can significantly outperform those that are not, and their memories and experience from learning are more positive than the memories of students who were timed or had other constraints. District technology leaders' awareness that the ISTE standards in conjunction with a framework such as the TPACK would greatly enhance teaching and learning and will help steer their district's technology implementation towards a more modern integration.

Districts are also recognizing that contemporary literacy skills that allow for proper use of communication and information through technologies such as social media and cloud computing can greatly improve students' ability to communicate and manage information; skills that are becoming a necessity at every grade level and a requirement for major curricular and pedagogical activities for the 21st century. Furthermore, today's digital age is pushing for greater computational thinking (CT) skills in curriculum standards to promote greater student mastery of analytical and technological skills that are predicted to be vital for the modern society and work environment of not too distant future. ISTE (2016) standards promote CT, emphasizing problem decomposition, pattern recognition, development of algorithms, use of abstractions to represent data, simulation, and analysis of data while making sure that students also build their social and emotional skills through the implementation of CT as much as possible. Platforms such as Snap! from UC Berkley or Scratch from MIT allow teachers to make computer programming accessible to children starting as early as the kindergarten grade level. Iterative exploration, promoted by the ISTE standards, paves the way for greater CT implementation and can prepare students for advanced computer science studies that require a great deal of problem-solving and reverse engineering abilities in a computational context within the K12 curricular environment (Grover & Pea, 2013). Many districts are already using or promoting Fab Labs and makerspaces for their elementary to secondary students to give their students greater exposure to CT and to encourage a wider implementation of computer science curriculum type curriculum in their district (Barr & Stephenson, 2011).

School districts can start CT related strategies starting with their youngest students. Researchers Bers, Flannery, and Kazakoff (2014) emphasizes the importance of exposing young children to CT starting with a more playful implementation that may start with some toys that can use elements from such things as video games, robotics, simulations, or model building to assist with CT curricular objectives. In addition, digital strategies that intermediate virtual and physical worlds can provide fun ways to build lessons that require computational models, for instance, projectile motion and other simulations in virtual environments such as games or computer simulations can be used teach CT concepts and to tackle complex or more advanced concepts that are not easy to handle via non-digital means (DiSessa, 2001). Districts can initiate projects that involve the use of robotics in elementary schools and carry on to upper grades by tweaking the curricular demand, rigor, and complexity as students advance, leading students to build robots with advanced capabilities that would be able to compete in competitions or be useful for their future careers (Bers et al., 2014). Lye and Koh (2014) assert that a CT-rich curriculum that helps students with concepts similar to what is taught in computer science (such as abstraction or decomposition) could greatly extend to everyday life. Lye and Koh have also found that many studies report positive outcomes for CT, with the suggestion that a constructionism-based learning environment facilitates better implementation of computational practices and perspectives that help students create something concrete (e.g., program or comments) to consolidate and demonstrate what they have learned. Twining, Raffaghelli, Albion, and Knezek (2013) suggest that ISTE standards should be considered when a district consider policies and practices that are transformative with emphasis on moving the district towards preparation for digital age teaching and learning. Through ongoing training that consider policy, governance, settings and the need for each stakeholder, districts can better support the uses of information technology and pedagogical shifts that are required to extend the range of modern teacher practice. Relevance for CT is becoming more profound every day, as computing has already started to have a major impact on every field of endeavor. For instance, drivers like science, technology, and the overall evolution of the society with technology are already showing a need for CT mainly due to sequential increases in the amount of data and continued complexities that are associated with handing off information (Wing, 2008).

Modern pedagogical practices focus on ISTE standards, which consider both students' social and emotional skills, as they are grounded in the latest research that shifts the focus of student development away from self-esteem, which was a major consideration during the 2000s, toward so-called soft skills, including perseverance, a growth mindset, and executive functioning to empower learners (ISTE, 2016). The latest ISTE standards refer to recent findings obtained by the World Economic Forum (2016), indicating the existence of a positive correlation between emotional skill building and students' academic achievement. ISTE (2016) realizes that measuring such skills may be difficult; however, these skills are considered important and are embedded throughout its standards.

District leaders also need to be aware that a technology centered plan to educate students needs to provide balance among emotional, social, cognitive, and language development needs (National Scientific Council on the Developing Child, 2007). ISTE standards can help districts narrow the achievement gap that is typically is a concern by most districts by giving students and teachers a repertoire of approaches for problem-solving and help students move from a fixed mindset to one that is called the growth mindset. A growth mindset allows students to think that their intelligence or cognition continues to be developed instead of being bound to a fixed boundary: this is a key consideration that school districts can use in motivating students to advance their achievement (Dweck, 2007) continually. Hochanadel and Finamore (2015) reiterate that pedagogical practices that encourage a growth mindset allows students to overcome various academic challenges, and ISTE standards provides the opportunity through its framework for teachers to develop robust lessons that would enable students to increase their learning continually and to create solutions that embody a growth mindset theoretic point of view. Meltzer (2010) suggests that in the 21st century educators should consider pedagogical approaches that would help students to develop such abilities as goal setting, prioritizing, organizing, self-monitoring, initiating, and planning, all of which are part of what is known as executive function processes, which can lead to greater academic outcomes and education technology tools can assist with. The World Economic Forum (2016) has put forth a vision for education technology that outlines a framework in which ISTE standards factors in prominently, through which educators are reminded to consider social and emotional learning and character development as well as such factors as curiosity, initiative, persistence/grit, adaptability, leadership, and social and cultural awareness, for their students to be more successful in an ever-changing technologically rich environment with their implementation of modern pedagogical approaches.

Rapid advancement in technology necessitates for school districts to develop strategies for gaining a global sense of what is on the horizon and beginning of the preparation process necessary to accommodate useful technologies for timely implementation. School districts should also consider that rapid advancements in technology will make some emergent technologies available very quickly, many of these technologies are discussed in the field of science and philosophy that focuses on predicting the future and is called Futurism. The Institute for the Future and the 2014 and 2015 NMC Horizon Reports (New Media Consortium & the Consortium for School Networking, 2014, 2015) have inspired ISTE to design relevant standards for today's students, stimulating ideas and understandings about the role of emergent technologies in education to prepare students for the workforce of the future. Most labor market experts argue that the future job market will be radically different and most of them would agree that today's students are preparing for jobs that have yet to be created. Each iteration of the ISTE standards aims to be in tune with the most current developments in education technology based on existing research in the field to remain relevant and be impactful for at least 5-10 years (ISTE, 2016). According to the Institute for the Future (2011), in the next two decades, major drivers such as demographic shifts, large data, and smart machines will transform many aspects of society and the labor market with occupations that are unfamiliar today. For instance, in the healthcare sector, big data will pave the way for greater personalization of medicine; in many industries, de-institutionalization has already started through improved access to various types of enabling technologies. This rapid global acceleration in change will require employees to be able to cope with various levels of volatility and uncertainty. Redistribution of labor will most likely occur because of intelligent machines as machine-human partnerships quickly move forward. Advanced physical materials, programmable matter, and 3D printing will present new manufacturing realities for consumers and the producers. Finally, big data is projected to be one of the lead drivers of change in society, as more data will be produced in the next ten years than in all human history collectively due to the proliferation of high-quality sensors, data centers, and improved computing technologies.

School districts are preparing students for the future economy. Therefore, they must acknowledge that the future economy will be highly flexible; as such, the labor market will favor workers that are highly skilled and can retool and upgrade their skills on an ongoing basis. The reduction in the number of knowledge workers and low-paying jobs will cause a significant disruption to the economy as automation continues to grow rapidly and more college students find their degrees largely obsolete by the time the graduate. It is already apparent that organizational structures will be optimized by guidance from algorithms and smart software to reduce cost and increase efficiency. The future will also bring lower costs of coordination of person to person, which will create opportunities to more efficiently raise capital through such methods as crowdfunding that can greatly enhance individual entrepreneurial activities and change the dynamics of the economy (Institute for the Future, 2014).

District leaders would benefit their district by investigating key trends that are the driving force for future advancement, acceleration in technology utilization, as well as indicators of any obstacle that might impede technology adoption. Additionally, it will be in the best interest of school districts to remain vigilant and to detect new developments in the education technology space, as some of these developments may be very disruptive and may pose a threat to the district’s existing operating model or may give the district some tactical advantages over other competing districts. Educators are beginning to realize that creating authentic learning opportunities and integrating technology into teacher education is becoming more manageable due to recent advancement in technology and greater access. Today, there are more mature technology strategies that play out in many classrooms, and the endless number of innovations that continue to drive such trends as blended learning is transforming the way subjects like Science, Technology, Engineering, Arts, and Mathematics (STEAM) to name just a few are being taught. Personalization of learning and rethinking the role of teachers given the rapid changes in technology seems to be an area that continues to require attention as districts plan for technology integration. According to the 2015 publication by the NMC and the Consortium for School Networking (CSN), there is rapid development and applications for education technology in different domains of technology such as consumer, Internet, social media, and visualization that can highly disrupt teaching as it used to be. There is also a greater recognition nationally by researchers and education technologists that push forward initiatives that ultimately end up having a positive impact on teaching and learning.

There is a growing number of organizations that are essentially beating the same drum when it comes to education technology. For instance, CSN has recently received input from a large community of educators and technology experts, suggesting that within the various areas of technology, there are many tools and resources that can be particularly helpful to P/K-12 education. CSN points out several technologies, including consumer technologies like 3D video, drones, robotics, telepresence, and wearable as they are gaining traction in the education arena. Many districts have started using various digital strategies to capitalize on the excitement created by Internet technologies such as cloud computing, networked objects, and semantic applications. For instance using strategies such as Bring Your Own Device (BYOD), flipped classroom, location intelligence, and makerspaces can help school districts reach a wider audience and give them the opportunity to service the need of their digital natives. Furthermore, software assisted adaptive learning, digital badges, learning analytics, mobile learning, online learning, open-source software, and virtual and remote laboratories to just name a few are gaining momentum. Moreover, social media technologies such as crowdsourcing, online identity, and social networking are also creating additional overlays or dimension for students and teachers so that they can make their connections more impactful. Some visualization technologies like 3D printing, AR, information visualization, visual data analysis, and volumetric and holographic displays have reached enough maturity to quickly advance into mainstream classrooms as each technology promises to make learning more accessible; as such, a school district's technology plan needs to be flexible to allow teachers to experiment and tinker with emerging devices and software quickly. For instance, any red-tape or arduous processes that may hinder rapid deployments or trials can significantly curtail implementation. Other enabling technologies that have recently seen much discourse within academic circles include affective computing, electro-vibration, flexible displays, machine learning, mesh networks, mobile broadband, natural user interfaces, near field communication, next-generation batteries, open hardware, speech-to-speech translation, virtual assistants, wireless power and so many others with potential to significantly disrupt how teaching and learning happens. The future will bring many challenges and opportunities as we continue to further our understanding of different learning technologies while each one evolves creating the biggest driver shaping the future of education.

Digital Citizenship

As technology utilization and Internet use become ubiquitous, the definition and purpose of digital citizenship continue to evolve, and it becomes more urgent for district technology leaders to be aware of such factors as student safety, legality, and ethics of online participation relating to teaching as well as learning. Based on the current understanding of what digital citizenship means within many academic circles, ISTE (2016) standards try to define digital citizenship along with online responsibilities and human privacy rights so that educator can use it within the correct context. CSM conducted a study in 2015 with a primary focus on documenting media activities of young people concerning time, enjoyment, age group, gender, race/ethnicity, and socioeconomic status. The study found a variety of patterns and preferences with which young people interact with various types of media; for example, young tweens and teens are especially interested in watching TV and listening to music, as they are mostly consumers rather than creators of content. Furthermore, age group pattern of behavior is highly impacted by socioeconomic, gender, and racial/ethnic differences. A school district technology plan would benefit from such findings with the consideration that media has an enormous claim on young people's time and attention. The study also found that on an average day American teenagers ages 13-18-years-old consume nearly 9 hours of entertainment media, whereas younger tweens (8-12-years-old) average about 6 hours; school districts can use this type of information to push relevant educational content through means that teens are already familiar with. For instance, districts should promote the use of social media for the purpose of instructing students using digital citizenship strategies. According to Gehl (2013), social media sites such as Facebook, Twitter, and Google have the power to influence the thoughts of their users while these services immerse them in their services and marketing content; the companies extensively monitor user activities, so they can provide users with relevant content that could potentially expose each user to a certain amount of exploitation with direct threats to their freedom or agency. These companies can customize user experience based on the flow of data that they continually collect on each user to achieve specific objectives. A district's technology plan must have the mechanism to stay current with latest social media technologies and to be able to educate students on how they can responsibly manage their online participation.

It is now common knowledge that almost every student owns or can operate a mobile computing device. Mobile devices have exponentially increased students' online participation. Lenhart (2015) cited a survey by Pew Research Center that 91% of teens that go online use some type of a mobile device; 33% of teens use some type of a messaging apps, a typical teen sends 30 text messages per day, 33% of girls use pinboards like Pinterest or Polyvore, 17% of teens use online discussion boards, 72% of teens play peer to peer video games, 47% of teens use video calling, 71% of teens use Facebook with an average number of 145 friends, half of the American teens use Instagram with an average of 150 followers, 41% of teens use Snapchat, 33% of American teens use Twitter with about 95 followers; social media use greatly varies by socioeconomic status, age, race, and gender. It is apparent that future use of online activity continues to increase and will evolve as new technologies continue to change the landscape of online participation; as such school districts' vigilance in how students use information and participate socially online can greatly benefit transformative instructional technology strategies.

According to Ribble (2015), school districts need to seriously consider digital citizenship as it relates to improving student outcomes and preparing students for the 21st century. Ribble separate digital citizenship into three broad categories: (a) effect on student learning and academic performance, including digital literacy, communication, and access; (b) effect on school academic climate and student behavior, including digital security, online etiquette, and digital rights and responsibilities; and (c) effect on student life outside of the school environment, including health and wellness, law, and general commerce. Ribble asserts that the three categories are interrelated and are not stand-alone issues so that districts may consider the integration of digital citizenship they way they see fit for their use.

Districts cannot take for granted that all their students are equally familiar with the Internet protocols of use. Researcher Wong (2015) asserts that digital natives are not very familiar with the Internet protocols due to lack of training, until such time more teachers participate in the active teaching of digital citizenship at their schools. Wong further states that without proper knowledge of the Internet user protocols, students would not be able to navigate it or take full advantage of what it contains; just because teens are immersed in social media, it does not mean that they have the skill or the knowledge to make the most of their online experiences. Districts also need to know that being a digital native can also mean that some students may have a distorted realty, because of not knowing much about online participation (Boyd, 2014). For school districts, it is vital to incorporate an interdisciplinary curriculum that involves some level of digital citizenship to address today's virtual encounters and experiences by the students (Wong, 2015). A district technology policy that considers student privacy and establishment of online safeguards for students' data is crucial, as the digital footprint of what is exchanged by students online can leave permanent records on one or more severs somewhere in the cyberspace, which could have negative repercussion for the students in the future (Zeide, 2014).

Content Curation

Digital strategies such as content curation, which refers to assembling, managing, and presenting some collection of information are gaining traction as students and teachers increase their interaction with the Internet and online content. In the digital age, the vast amount of information, interconnectedness, and digital tools for the acquisition, construction, and demonstration of knowledge require that school districts consider ways to help students acquire computer and online skills to be able to curate their collections of information, which require students to use higher-order thinking skills to construct and to share their deep knowledge or creativity. For instance, ISTE (2016) standards allow educators to help their students become more knowledgeable constructors, digital citizens, creative communicators, and global collaborators; these roles epitomize the dynamic skills required for digital curation. The impact of digital curation is already seen in many sectors in the society due to the continued massive shift from paper to digital environments. Additionally, access, maintenance, and upkeep of digital information are becoming increasingly important for many organizations including schools; developing students' ability in digitization of information, and digital content curation is becoming a necessity digital information is exponentially growing (Beagrie, 2008). With the increased use of social media and the rise of online personal identities, students can socialize as well as personalize their learning, as digital curation allow students to be more innovative with their digital online participation (Gadot & Levin, 2012). Gadot and Levin (2012) further emphasize that curation leads to the development of contemporary content areas that will also push further the level creativity in both teaching and learning. School district technology leaders should consider that, as the world continues towards becoming more media-centric, it necessitates the development and support for media-savvy students and teachers (Tisdell, 2008).

School districts needs know that student engagement with digital content requires a thoughtful approach. Mihailidis and Cohen (2013) stated that content curation is a critical component of digital and media literacy, proposing a framework for media literacy that features curation as an important competency. The curation framework that districts need to consider outlines both teacher and student responsibilities, defining curation as a student-driven, creative, collective, and highly exploratory activity that involves the integration of different multimedia and storytelling methods. A media literacy framework should be guided mostly by pedagogical shifts that would allow classroom teachers to lead media consumption and production with a critical eye on evaluation and analysis of content. Furthermore, the district needs to plan so that there is access to a working computer, Internet access, and basic web navigation skills training for every student and staff as a first step to ensuring that digital and media competencies are brought in to every classroom. Districts would benefit when they are aware of content curation and consider it as an important part of the teaching and learning process for the modern classrooms of the 21st century.

Blended and Online Learning

Blended and online learning is an emerging strategy that seems to be taking off due to greater access to the Internet and greater access to computing devices. Many districts are finding it necessary to offer blended or online learning due to strong demand and to compete with many online competitors that are increasingly threatening the traditional brick and mortar model that most districts are currently involved with. The International Association for P/K-12 Online Learning (iNACOL) has defined blended learning in the following way:

> Anytime a student learns part of their curriculum with direct supervision from a brick-and-mortar location away from school through an online mechanism of delivery that gives the student the control over where, when, how and the pace of the lesson is what blended or hybrid learning is all about (Worthen & Patrick, 2015, p. 3).

Other researchers also define blended learning as a method of delivering formal learning experiences that combine traditional brick-and-mortar and online learning (Freeland, 2014). Districts can leverage the increases in Internet bandwidth, cloud computing software, powerful new LMS platforms, and other technologies to create a viable new category of lesson delivery for their students. Today P/K-12 online and blended learning technologies are evolving rapidly; as of 2014 there were a considerable number of blended learning opportunities for students in all 50 states; online charter schools, consortium programs, and single-district online programs are gaining ground while private providers are also starting to make their presence known. Many school districts have chosen to offer blended learning instead of the traditional brick-and-mortar or one that is fully online by taking advantage of online educational resources and in many cases the cost savings from such programs. Additionally, many school districts are using online and blended learning programs to meet better the need of their special needs students and those students that require homeschooling (Ferdig & Kennedy, 2014). The increasing demand for online learning from a hybrid model that blends some online methods to entirely online models is threatening the traditional face-to-face learning models of the past. Districts can use blended learning strategies that are embedded in ISTE. For instance, at their core, ISTE (2016) standards have a key goal of helping students gain more control over the pace, flow, and focus on what they are learning. Blended learning affords students greater opportunities than the traditional face-to-face model. ISTE standards support an entire spectrum of blended learning implementation, from a fully flipped model to various types of hybrid approaches. ISTE standards acknowledge that blended learning environments are becoming more abundant and district technology plans must consider these environments carefully, as they are important vehicles for student empowerment.

Districts' awareness that blended learning cannot just be done casually is an important first step; rather, blended learning requires a careful team effort approach by all district stakeholders and especially those that are responsible for managing district's instructional programs and strategies. Moreover, blended learning is not a cure for bad teaching, as there is a wide range of products and services that require lots of vetting and figuring out by teachers, and there will be many surprises for the district and learning curves for the students and teachers throughout the process (Chan, 2014). Chan (2014) further recommends that a school district's technology plan needs to include: staff development for blended learning that include all stakeholders, a careful rollout plan that is already outlined in a district technology plan with the mechanisms that are thoroughly planned and funded, which are building on best practices that others have already tried to get the best results and high rate of participation. Also, district training programs and activities for their online instructors are most effective when pedagogical content knowledge is combined with efforts to build or connect with communities of learners that share the same practice (Ferdig, 2010b). Online and blended learning can be a successful path for those students that normally cannot attend the traditional school, such as dropouts or those students who are expelled due to various reasons (Ferdig, 2010a). Many districts are currently unprepared to offer online or blended learning opportunities due to a lack of necessary experience or other constraints like funding that prevents them from being able to transform their existing practice (Ferdig & Cavanaugh, 2011).

In 2013, some states, including Alabama, Florida, Michigan, Virginia, North Carolina, and Arkansas, began to require students to take some online courses to graduate. Other states like Georgia, New Mexico, Massachusetts, and West Virginia have approved legislation to encourage implementation of online courses (Ferdig & Kennedy, 2014). For decades, ample research findings have found positive outcomes related to many types of online teaching and learning activities (Chan, 2014); however, for wider implementation, each district's technology plan needs to start provisioning for the necessary conditions that can support both online and blended learning (Ferdig, 2010b). District strategies will require continuous engagement due to the continued emergence of newer technologies and digital strategies for either online or blended learning. Blended learning also supports existing district plans that are focused on offering students competency-based education, which many school districts are now looking to use as a way to help them depart from traditional school structures (Freeland, 2014). According to Freeland (2014), online and blended learning provide students flexibility with pacing, the opportunity for on-demand assessments, great flexibility with how content is delivered, and a broader range of personalized tools to meet the need of individual students; these assertions reiterate the recommendations of many other researchers as well. Blended learning has great potential in supporting personalization in 21st-century schools; therefore, when creating a district technology plan, the technology leaders should consider mechanisms that provide structures to promote blending learning. Additionally, a school district's information technology network hardware and software infrastructure must be robust enough to support blended and online learning, as unreliable network connectivity with limited bandwidth or network hardware that is not able to support the most modern learning management software programs can be a great hindrance to a successful blended or online learning implementation model (Murphy et al., 2014). There should also be evidence of a framework such as iNACOL blended learning competencies (which addresses student mindsets, qualities, adaptive skills, and technical skills) in a school district's technology plan, which can build high expectations for all stakeholders, strengthen district's commitment to achieving equitable results, move the educational program toward competency-based learning, and systematically improve learning for all students (Powell, Rabbitt, & Kennedy, 2014).

Informal Learning and the Maker Movement

There is much interest in giving students opportunities to explore informal learning via non-traditional curricular and pedagogical strategies. Informal learning and the maker movement strategies are emerging as one of importance and serious consideration for implementation along side a well-balanced district technology integration plan. ISTE (2016) standards acknowledge that the maker movement is a trend that is helping to rethink education. ISTE standards allow teachers to let students tinker or figure out how things work via activities that fit the maker movement strategies by allowing students to make prototypes and figure out processes, which has become much easier with technologies such as the 3D printers. With ISTE standards, principles such as project-based learning, development of social and emotional skills, critical thinking, and fostering skills that lead to better communication and collaboration can be reinforced within curricular and pedagogical strategies. School districts' technology plans should have provisions to allow students to design-make-play along with the principles of informal learning, which the maker movement is largely based upon. Furthermore, as students use engineering design processes to tackle real-world problems in innovative ways, they can also uncover many learning opportunities from the expressive, creative outcomes of the activities through play and interaction with each other (Honey & Kanter, 2013). Seymour Papert would agree that in a makerspace classroom environment, students' passions and interest would be off the charts at extraordinarily high levels. Through the lens of Papert's constructionism, teachers' pedagogical strategies that would allow students to invent and put their work publically on display using such tools as digital fabrication where students can easily externalize their learning (Blikstein, 2013). According to researcher Blikstein (2013), digital fabrication can dramatically enhance existing curricular practices of the teachers and expertise of their students by moving new inventions and complex design cycles quickly through the processes by creating opportunities for major projects and deep collaborations from basic to most complex curricular initiatives. District technology plans that allow for students to delve into design thinking opportunities can pave the way for students to become investigators, problem solvers, communicators, collaborators, resourceful and independent thinkers; these roles embody the curricular and pedagogical approaches that are necessary for the 21st-century skills that are useful for today and the future job market (Gray, 2013).

Global Citizens

Lately with the affordances of online social interaction constraints with geographical boundaries have largely become nonexistent when it comes to collaboration and sharing of information globally. A district technology plan needs to consider that students can no longer be constrained within the boundaries of a school. Students need to collaborate and have access to information globally and without constraints of either distance or space. ISTE (2016) standards acknowledge that meaningful connections can be made through technology and that most of the today's problems require global solutions, as today through robust networks students can easily connect virtually and dynamically with anyone around the world to tackle problems or share information either via synchronous or asynchronous ways of communicating. ISTE believes that technology can provide the means for teachers to design lessons that will enable their students to tackle problems authentically and through greater virtual collaboration globally.

Connections between the ISTE Standards for Students and Other Education Initiatives

For districts to adopt any new standards or methodologies, they need assurance that the new standards will not cause major disruption to their existing curricular and pedagogical initiatives. The framework that ISTE (2016) standards provide will support and strengthen existing district academic initiatives and can facilitate in-depth learning that is appropriate for today's digital age students through an amplified use of technology with a re-visioned pedagogy that can significantly improve modern teaching and learning. District technology leaders need to be aware that ISTE standards work alongside other existing initiatives and frameworks without superseding them; ISTE aims to improve implementation of the CCSS and the Next Generation Science Standards (NGSS) by helping to deepen student learning. ISTE standards can also pave the way for implementation of a school district technology plan that relies on such innovative implementation models like SMAR also known as Augmentation Modification Redefinition Model (Hamilton, Rosenberg, & Akcaoglu, 2012), or a more thorough framework like Koehler and Mishra's TPACK.

Consideration for School District Leadership (Planning & Budgeting)

The most critical step towards technology implementation is most likely attention to planning and funding. It is important for districts to be prepared and be able to tap the unlimited potential of emerging technologies and to steer themselves towards a new direction that leverages technology, which is becoming ubiquitous and is posing significant challenges and opportunities (Schrum & Levin (2016). Many of the new technologies that are now practically mainstreamed such as Twitter was not even in existence ten years ago from 2017. For district leaders to effectively develop funding and planning strategies for technology implementation in the areas of instruction, communication and administration it is critical that they realize the challenge and learn how to effectively leverage the available information about the various technologies to effectively incorporate into their daily practice. School district leaders must embrace the idea that they cannot by themselves be the know it all and can do it all; rather they must embrace the skills and strategies of developing a shared vision through the lens of what is known as distributed leadership to simultaneously manage and address the many challenges with funding and planning that technology implementation brings (Murphy, Smylie, Mayrowetz, & Louis, 2009) and that means there is a great deal of necessity for networking globally and to involve as many contributors or stakeholders with the process as possible.

District technology leaders must develop the ability to listen attentively and take note of experts' recommendations, and what the various stakeholders are asking and talking about

(Moos & Johansson, 2009). Incorporating everyone's input in the planning process is very involved and will requires a lot of effort by the district leadership to synthesize a functional plan that is fundable; as there is no such thing as bringing change overnight, any change that is meant to be sustainable require not only involving everyone's continuous input but also building leadership capacity within all layers of the organization from the student to the Superintendent (Levin & Schrum, 2012).

When school district leaders talk about integrating technology as a mechanism to improve instruction, communication, and administration they must plan out all aspects of what will be involved in the process such as the funding, support for users, stabilization, and expansion of existing IT hardware and network software, and staff professional development around all aspects of technology implementation (Schrum & Levin (2016). Schrum & Levin suggest that based on studies district plans for technology should include all parts of the school district's operation from the curriculum, pedagogical approaches to technology in concert with funding availability for technology implementation to work. Therefore, for the technology leaders to make a difference in the overall system, they must pay attention to all the moving parts of the district operations. For instance, to achieve student-centered classroom instructional strategies by teachers, they must push for funding of more professional development that is high quality and on-going (Levin & Schrum, 2012). It is also important that technology leaders keep a close eye on changes that new plans will bring with the overall existing school district's culture (MacNeil, Prater, & Busch, 2009) so that their planning efforts are strategically positioned and do not destabilize district's operations.

District members that are involved in planning must realize that the Internet is a preferred method of access many of the modern learning tools for the 21st-century education (Project

Tomorrow, 2011), they must look at ways to increase access to the Internet so that students can use their cell phones and other digital devices for learning. Preparing students for tomorrow's workforce will require school districts to create more ways that student can access crowdsource information pools and gain greater access to new solution or strategies for immediate consumption. School technology leaders need to look for ways to increase student access to technologies that help enable, engage and empower students in as many ways as possible (Project Tomorrow, 2011). District technology leaders need to know what teacher's beliefs are about teaching and learning and how teachers make curricular and pedagogical decisions to use with technology (Ertmer & Ottenbreit-Leftwich, 2010); this insight will give a tactical advantage to technology leaders as they plan for appropriate and timely diffusion and integration of technology. Just because the amount of technology that is around increases it does not necessarily correlate to better teaching practices or learning (Miranda & Russell, 2012); therefore, district leaders must look at ways to remove both internal and external barriers so technology integration become more effective and yield better student outcomes (Hofer & Swan, 2008). Furthermore, district leaders must acknowledge that students need access to technology that allows them to connect globally; therefore, district technology leaders must advocate for adequate funding a technology infrastructure that is built so that students can have better opportunities for e-learning and access to other emerging technologies (Hillard and Jackson, 2011, p4). The district must provide means through adequate funding for teachers to gain access to information and technological tools so that they shift their pedagogical strategies by no longer remaining the sole source of information or the ‘sage on the stage,' but rather they would use technology to become better facilitators with more engaging lessons.

Another planning challenge for technology leaders is the present culture within the school organizational structure (Harris & Hofter, 2011, p. 213). One of the planning priorities needs to account for how to change the culture to favor technology. Often small and strategic planning steps are required while keeping in mind user's comfort level to methodically inch forward with each technology project (Ertmer and Ottenbreit-Leftwich, 2010). It is imperative for the leadership to increase their awareness of how to best present and fund new technologies to the staff and focus on aspects that improve district teaching and learning objectives (Hazy, 2011). There are many technologies that can immediately play a critical role in fundamentally changing the school district culture and how it conducts business; for instance, online-learning, gamification, blending of formal and informal education and makerspaces are just a few examples of areas that district leadership can impact quickly by spending much time understanding the ramification and allocate adequate funding to support it.

Successful technology leaders need to use a systems-thinking approach when they plan to effectively leverage technology for school improvement (Levin & Schrum, 2012). A systems-thinking approach can improve technology implementation and help reduce digital divide that may hinder student's ability to fully participate in the 21st-century knowledge economy and society according to the organization for economic cooperation and development (OCED, 2010 p. 2) study. Also, technology leaders must remain grounded in that technology planning is first and foremost should consider people first then the technology (Mollette & Vasu, 2011). That means that plans cannot be just drawn up in closed doors using an excel spreadsheet considering just a few factors such as cost or logistics. Also, the technology plan needs to be organically developed, as there is no such thing as an 'ideal' plan that the can be adopted from another school district or purchased from a third-party vendor.

According to Schrum & Levin (2016), successful technology leaders need to wrestle with questions regarding: How much technology needs to be implemented? How does bringing your own device (BYOD) will be handled? What pathways to consider for the expansion of the IT infrastructure? What is the right level of user support? Is the existing district technology policy and practice up to date and are how is it district's current technology vision? Does the technology plan allow for enough flexibility to cope with new options and opportunities? How is the district positioned to take full advantage of external funding resources such as E-rate? Schrum & Levin site other research and suggest that working on development of a shared vision through a systematic process that involves distributed leadership can greatly increase technology planning and implementation; leading the management of technology planning, infrastructure design and step by step implementation of technology initiatives are essential activities for district technology leadership; district's commitment to professional development should be embedded throughout every aspect of the technology plan, and the leadership's involvement should also be quantified along each step. Ultimately leadership's ability to keep a close eye on ways to improve instructional practices with technology and to resolve implementation complications quickly can positively impact district's operations and prevent regression in instructional practices so that students realize their ultimate potential.

Chapter Summary

The purpose of this descriptive research study is to determine the extent to which school districts leadership is aware of relevant 21st century education technologies, modern practices, and relevant policies that conform to the latest education technology research and standards, such as those established by ISTE; this study also examines district technology leaders' familiarity with the intermediation between technology, pedagogy, and curriculum, which is an important consideration for district technology preparation for implementation. In addition, this study probes to understand the kinds of constraints, supports, problems, or issues related to policy and practice districts perceive that impacts a district's ability to plan, budget and adopt the technology.

This study is guided by the following three research questions:

1. How aware is the district technology leadership with the trends in current technology? How aware is the district technology leaders of the intermediation between technology, pedagogy and curriculum?
2. What constraints, supports, problems, or issues related to policy and practice does the district technology leaders perceive that will affect district's ability to plan, budget and adopt technology?

This chapter looks at a wide body of research to gain perspective for this study. The data from this study can be used to identify potential gaps in current research and establish a baseline from which school districts can guide and improve the effectiveness of their technology implementation. The findings can also be used to provide insight into what roles and responsibilities district technology leaders may play in order to expand or refine their existing district technology plans and to gain strategic advantage in areas of technology planning, policy development, leadership capacity building, development of strategies for professional development, and prioritization of district resources for a more effective technology implementation and utilization.

Chapter 3: Methodology

Although the debate about the role and value of technology in schools persists, school districts must plan, acquire, and maintain a variety of technological capabilities including infrastructure preparedness to maintain their relevance amongst districts that can withstand the demands from the modern pedagogical shifts that are taking place as result of accelerating infusion of technology within the various aspects of the society resulting in greater demand from the new generation of students that are also known as the digital natives. New technologies are constantly emerging, and school districts must make decisions about their relevance, affordability, and burdens before they become mainstreamed to maintain their competitive edge against. How are these decisions made? Who is involved? What criteria or knowledge base informs them? This study attempts to understand school districts' general awareness of a vast array of emerging technologies through their key decision makers that hold titles of Superintendent, Director or site Administrator, which could potentially impact the choices and decisions they are making. An extensive body of research suggests that school districts cannot effectively serve their students' need for the 21st-century education without first working to understand the emerging technologies and strategies for integration of technology that are vital to the advancement of teaching and learning for the 21st-century. The study focus is to answer three research questions: (a) How aware is the district technology leadership with the trends in current technology? (b) How familiar are the district technology leaders about the intermediation between technology, pedagogy and curriculum? (c) What constraints, supports, problems, or issues related to policy and practice does the district technology leaders perceive that will affect the district's ability to plan, budget and adopt technology?

The Design of the Study

This descriptive study uses a survey as the main mechanism for data collection, and it relies on a convenience random sampling method for data collection. The theoretical framework for the development of the survey tool used in this study is based on common themes that are identified within the latest research that relates to technology implementation and associated constraints that exist within factors such as funding, planning, implementation, policy, and practice. The design of this study further considers the latest updates from the 2016 iteration of the ISTE standards that echo recommendations that are made by the latest publications from New Media Consortium (NMC) Horizon Report (New Media Consortium & the Consortium for School Networking, 2015), and the 2016 U.S. Department of Education's National Technology Plan.

The survey tool used in this study allow for gauging of the necessary conditions that need to be within the grasp of a school district to successfully implement modern technology strategies that are largely outlined by the latest research on planning and implementation of modern curricular and pedagogical strategies that rely on technology. This study also considered the recommendations from the latest publication of the National Technology Plan, which calls for equitable access and improvements to all aspects of technology implementation, along with the NMC's Horizon Report's recommendations that identify the latest trends within emerging technologies that districts needs consider. The section of the survey that asks questions about the intermediation between pedagogy, curriculum, and technology draws from research that supports the TPACK framework. The scope of this study is limited to California school districts with demographics that range from districts that are located within rural to large urban areas with student population ranging from 1,020 to 600,000 across all grade levels from preschool to 12th grade within Elementary, High School, and combined K12 school districts.

Sample and Population

The population for this study consisted of school district leaders that generally play a significant role in how school district's technology implementation from policy development to practice is carried out, and as such, this study is focused on districts' top leadership staff that include Superintendents, District Directors, and site Administrators. The most up to date school district administrators' email contact list was obtained from the California Department of Education's database, which is publically accessible through the department's public-facing website @ https://www.cde.ca.gov. The sample is constrained by the list that was made available by the CDE, which contains the list of many school administrators across California and may not have been a complete list. The sample is further constrained by the availability and willingness of those that were contacted to take part in the Survey. According to the California Department of Education (CDE), there were 1516 public school districts that were registered and were operating within the state of California for the academic year that started on July 1st of 2017; the registered districts were mostly classified under the designation of Elementary that covers grade levels from preschool to 6th grade, High School that covers grades levels from 9th to 12th, and K12 that covers grades from preschool to 12th. In the year 2017, CDE's student count from the mentioned 1,516 district were 6,226,737 students, with the districts locations that span across 58 California counties form large urban to small rural townships locations. According to the latest information from the CDE for the 2017 school year, there were a total of 11,564 school district administrators' email contacts that were registered in the CDE database.

The researcher for this study used Qualtrics survey management software to administer a survey via email (see Appendix C) to 11,564 Administrators from the 1,516 California public school districts. A total of 242 school Administrators that were classified under the job titles of

Superintendent, Director, and Site Administrator completed the survey questionnaire. The survey consisted of 30 main questions with some related sub-questions. from which 242 district administrators with job titles of Superintendent, Director, and site Administrator voluntarily participated in the survey.

Participant's overview: There were 242 participants that completed the survey from 189 school districts across California. Table 1 describes the participating districts' type classification as were distributed across district settings from rural/town to suburb/city areas. The demographics section of the survey allows for segmentation analysis that gives additional insights as to the nature of the participants' involvement with their district, district settings, district classification, district size, and other information for further disaggregation, cross tabulation, or analysis. The data in Table A1 shows how the 242 respondents were divided within 105 (43%) Elementary, 27 (11.2%) High School, and 110 (45.4%) K-12 districts. Additionally, there were 159 or (66%) of those that responded were participating from a single district, the remaining 83 or (44%) of the respondents were distributed between 2 to 4 respondents per district.

Participants for this study consisted of school administrators with job titles of Superintendent, Director, and Site Administrator working in Elementary, High School, and K-12 districts. Table A2 shows that nearly 2/3 of the participants were site Administrators that were directly involved with their site's implementation of the technology; 1/3 of the participants were district directors and superintendents that were tasked to play a critical role in the development of their district's technology vision with a district-wide impact on planning, budgeting, and policy development for technology implementation.

This study benefited by gaining insightful data on school district's population of students who are English Language Learners as well as low income to provide better generalization and segmentation of the results. Table A3 reflects the result of the survey's data that shows the average percentage of students that were designated as English Language Learners and were classified low income across the189 districts that participated; from 242 participants' responses, there was an average of 26.2% of the student population represented by all the districts that were receiving English language services; additionally participants reported that on average 59% of their students qualified to receive funding designated under Title I due to low-income criteria as supplemental restricted funding from federal government.

To gain perspective into the level of experience of district participants that were working with technology, respondents were asked to provide the number of years of experience relating to their responsibility with technology in the context of their work in education. Table A4 provides the breakdown of technology experience across the three different job titles of district Director, site Administrator, and the Superintendent that is arranged according to district type classification. The data has captured a combined average number of years of experience with technology from the 242 respondent to have mean of 4.7 years with a range from 0 to 11 years, and a standard deviation of 2.7 years from the mean.

In addition to the participants' technology experience, participants were asked to tell about their level of experience as educators. The data related to years of experience broken down by job title is referenced in Table A5, which shows the average years of experience at 21.7 years with a range from 4 to 47 years; the standard deviation from mean across the 242 Administrator's response was 7.8 years from the mean.

According to CDE's data, approximately 80% of the student population represented in all California public school districts are accounted for within the largest 25 public school districts that operate across the state. Table A6 provides district size data that was reported by the 242 respondents of the survey for this study, which show the average range of student population along with district settings. The range of total student population reported were from 600,000 to 1,020 per district. The average = 16,326, Median = 8,000 and the was Mode 10,000.

Instrumentation

A survey tool was developed and served to collect data on school district administrators' awareness of trends in technology, their familiarity with the intermediation between technology, pedagogy, and curriculum; and their understanding of perceived constraints, knowledge of technology support, problems related to technology implementation, or issues related to policy to practice that may have an impact on adoption of technology. The survey questions were developed to answer the three research questions; each section from II to IV is focused on one of the three research questions.

Section I of the survey is designed to collect demographic information, which has provided the data regarding such things as the districts' setting, classification or district type, professional experience of Administrators' with education and technology, approximate percentage of ESL students; and the approximate percentage of students that are considered low income using federal metrics for poverty through qualification for federal Title I funding. This section provides valuable insights for this study that has allowed for segment participation analysis and the identification of specific trends within the different segments of the population.

Section II of the survey is focused on district administrators' awareness of education technology using current research as the matric to develop the questions and capture data that will be relevant within the context in which district administrators work with regards to their awareness of current technology trends or what is considered emerging technologies within the space of education technology. The section contains thirty-five Likert-type questions with 6 scales: (a) don't know what this is, (b) have heard of it, (c) have demoed it or seen demos of it, (d) enough to use without help, (e) could help others understand when/why to use it, and (f) could teach it to others. The 6 Likert scales are used to allow for greater analysis to specific levels of respondents' overall awareness of technology within the practice of teaching and learning; the survey section continues with additional fill-in the blank type questions for capturing additional insightful responses from the respondents. The data from the questions from this section provides insight to answer research question I: How aware is the district technology leadership with the trends in current technology?

The questions from Section III of the survey measures district administrators' understanding of the intermediation between technology, pedagogy, and curriculum. The section consists of six Likert-type, dichotomous yes/no and fill-in the blank questions, which asks about technology leader's understanding of the intermediation between technology, pedagogy, and curriculum. The questions for this section were originally developed by researchers Mishra & Koelher to assess TPACK readiness for a specific subject; for this study, some of the questions were modified with their permission to be more general and fit the context of this study. The questions for this section focus on answering research question 2: How aware is the district technology leadership of the intermediation between technology, pedagogy, and curriculum?

The questions for section IV of the survey was developed to gain an understanding of what district administrators' views were with regards to such things as constraints and supports within the context of their work about technology implementation. The section consists of nine multiple choice and fill-in type questions that captures what a district administrator sees as an overall constraints preventing technology implementation for their district, technology support challenges, issues that hinder technology implementation, or issues related to district policy or practice that may have an impact on district's ability to plan, budget and adopt technology. The questions from this section help provide data that is instrumental to answering research question 3: What constraints, supports, problems, or issues related to policy and practice does the district technology leadership perceive that will affect the district's ability to plan, budget and adopt technology? Table A7 provides a planning summary that outlines objectives for each section of the survey instrument used for this study.

Survey Validity and Reliability

The validity of the survey instrument is established in three ways: (a) review of the literature, (b) discussion with field experts, and (c) pilot of the survey with feedback. Validity (face validity) of each survey question is established with direct measurement of the construct that is supposed to be measured. Survey questions are based on the latest literature review with a focus on education technology and modern strategies for the enhancement of teaching and learning for the 21st-century. The literature review also includes recommendations from research-based technology standards such as the most current ISTE 2016, the latest iteration of National Technology Plan published in 2016, and the latest 2016 publication from NMC's that also known as the Horizon report. The essential conditions that the survey questions are asking about must exist based on latest research and be within the grasp of school districts to improve technology utilization, which establishes content validity for the survey. Each question helps identify a specific factor that influences a school district's technology implementation, which is the intent of this study that confirms survey's internal validity. The results of the study can be generalized to cover school districts within a wide range of demographics including settings such as large urban to small districts located in rural areas, which establishes external validity of the instrument. The survey was piloted via administration to 10 currently employed school district administrators across different settings in California, and the results were examined to establish reliability as far as understandability, functioning, and online usability of the survey, whereby establishing that each question generate expected information each time it is used under the same condition. The survey questions were also individually reviewed face to face with ten currently employed school district administrators with first-hand knowledge and expertise with their school district's technology initiatives to get further feedback regarding the survey's content relevance. Administrators were asked to provide answers to the following questions: (a) Did the content of the survey address the intent stated? (b) Did the wording of any questions lead to any bias response? (c) Did the order in which the questions were presented cause bias in your responses? (d) How many minutes did you need to complete the survey? (e) What suggestion for improvement do you have for the survey? Feedback was used to improve the survey further to make a minor change to some of the wordings of the questions for better readability; the rest of the feedback and suggestions for improvements did not require any other changes to the survey.

Additionally, appropriate reliability analysis based on current research was conducted to ensure the reliability of the derived scales used in the survey questions.

Data Collection Process

The survey was conducted using Qualtric's survey platform and its email servers to send an email with a survey link to l1,564 potential participants that were originally confirmed as current school district administrators by the California Department of Education, which represent 1516 districts and from which 242 respondents agreed to volunteer by responding to the request to participate in survey for this study. Qualtrics terms of service provided the researcher the assurance that the collection procedures would allow standard implementation procedures that are in line with the terms of Institutional Review Board (IRB) protocols and approval such as secure transmission of data, informed consent notification, and database server security. The survey window was open for 30 days to allow for greater participation; from the 11,564 emails sent, 586 potential respondents previewed the survey questionnaire and from that 242 district administrators took the time to complete the survey. Each recipient received a unique survey link that could only be used by that one individual to help prevent multiple submission from the same recipient. The 344 respondents that only previewed the survey or did not meaningfully participate were excluded from the analysis for this study.

Protection of Human Subjects

Steps were taken to ensure the confidentiality and protection of human subjects involved by the requirements of the Pepperdine University IRB for this study. Potential respondents were informed in writing via the IRB's disclosure before they had access to the main part of the survey of efforts and safeguards that were in place to maintain each respondent's confidentiality through coding of any information gained from the survey data, as well as allowing for participants to voluntarily participate or opt out at any time before participating in the survey. This study posed minimal risk to human subjects, and the researcher acknowledges that conducting social research is based on constructs created and studied by humans, and as such, this study sought every opportunity to take the necessary precautions to ensure that proper research protocols were followed and were in place to protect the subjects involved in this study. The following protocols were followed for the protection of human subjects in this research. The researcher has passed the human subjects research training through Collaborative Institutional Training Initiative (CITI). This training includes topics related to human subject research such as risk, privacy, and confidentiality, which has also given the researcher the training for the appropriate safeguarding of data related to human subjects research. Procedures of the study were sent for approval to Pepperdine's Institutional Research Board (IRB). Pepperdine University policy (2016) states that all research relating to human subjects must be conducted by accepted ethical, federal, and professional standards for research and that all the research must be approved by one of the university's Institutional Review Board (IRB). Copy of the IRB approval letter is placed in Appendix D. All data that is obtained for this study is obtained in a way that was respectful of all survey participants using protocols to ensure full protection of human subject from any harm. Participants' anonymity was protected by not gathering or keeping any personal identifying information. Using Qualtrics to conduct the survey ensured that IRB protocols would be followed with regards to the anonymity of data to allow for removal or exclusion of all participants' identifiable information such as their email addresses or IP addresses. Additionally, research was conducted within established or commonly accepted educational settings, involving normal educational practices, such as district administrators answering questions in the context of their daily work with their current employing school district.

Data Analysis

Once data was collected and curated as data simplification, which is how data will ultimately be presented (Creswell, 2007). The data analysis procedures required a protocol for interpretation and classification, as data was read, re-read and then coded for some of the questions that participants wrote in their answers, all words and sentences were methodically read to figure suitableness for inclusion in the study (Strauss & Corbin 1990). The protocol for this research consists of an analysis of each section of the survey that contains questions with specific objectives to answer the three research questions posed in this study. (a) How aware is the district technology leadership with the trends in current technology; (b) how aware is the district technology leaders of the intermediation between technology, pedagogy and curriculum; (c) what constraints, supports, problems, or issues related to policy and practice does the district technology leaders perceive that will affect district's ability to plan, budget and adopt technology. Due to the nature of the data that was obtained from the survey, the mostly descriptive statistical analysis was used for the analysis and discussion of the results.

Chapter 4: Results

This chapter details this descriptive research study's results and uses the analysis of the survey data to answer the 3 research questions that guided this study. The purpose of this research study was to determine the extent to which school districts' leadership is aware of the relevant 21st-century technology applications for the modern curricular and pedagogical practices that latest research suggests. In addition, this study probed to determine how familiar the district technology leaders are with the intermediation between technology, pedagogy, and curriculum. Furthermore, the study sought to gain insight into the types of constraints, supports, problems, or issues that are related to district technology policy and implementation policy that district technology leaders perceive to impede their ability to move their district's technology initiatives forward.

Latest research suggest that it is important for school districts to have a clear and comprehensive understanding of the landscape education technology with special attention to the latest technology trends. Research also suggest as was outlined in chapter 2 that districts need to know the about how technology intermediates with modern pedagogical and curricular practices to be able to effectively increase technology utilization and how those understandings eventually impact school district policy and practice with regards to technology. The many drivers that are instrumental in getting districts to pay greater attention to technology can also pose many challenges for districts as districts continually prepare to overcome limitations; the data from this study also attempts to identify some of the limiting factors that make it difficult for districts to accommodate for the acceleration in demand for technology.

In the later part of this chapter the data analysis of the results is used to answer the three research questions that this study sought to answer: (a) how aware is the district technology leadership with the trends in current technology, (b) how familiar are the district technology leaders about the intermediation between technology, pedagogy and curriculum, and (c) what constraints, supports, problems, or issues related to policy and practice does the district technology leaders perceive that will affect the district's ability to plan, budget and adopt technology.

The findings of this study has identified implications for future research that is thoroughly discussed in chapter 5. In addition, this study has identified suggestions that can help guide development of a baseline for technology awareness that district Administrators must have within the context of their work to expand or refine the implementation of technology for their district through their participation in the development of policy, building of leadership capacity, improvements of strategies for professional development, and prioritization of resources to increase technology utilization.

The findings are organized in two parts, part one presents the data in the order of the survey questions and is divided into topics to better contextualize the data for descriptive analysis and discussion. Part two uses the findings that is presented in part one for answering of the 3 research questions that guided this study.

Findings (Part I) - Presentation of Data and Descriptive Analysis

Familiarity with New Technology

Familiarity with new technology topic is covered within the first part of the survey, which uses Liker-type questions with 6 scales.

Survey Question: Describe your level of awareness and understanding of these Technologies or digital strategies: (a) 3D printing, (b) 3D videos, (c) adaptive learning, (d) adaptive learning, (e) artificial intelligence, (f) augmented reality, (g) BYOD, (h) cloud computing, (i) coding, (j) crowdsourcing, (k) data analytics, (l) digital badges, (m) flipped classroom, (n) information visualization, (o) internet of things, (p) learning analytics, (q) location intelligence, (r) machine learning, (s) mobile/handheld computing, (t) online learning, (u) open hardware, (v) robotic tools, (w) social networks, (x) virtual reality, (y) visual data analysis, (z) volumetric & holographic display (aa) wearables,(bb) ISTE standards, (cc) LMS, (dd), and computational thinking.

Each technology or strategy that was asked about in this question used a 6 scale Likert-type question. The survey data for part of question (a – dd) is presented individually within Tables A9 through A38 followed by descriptive analysis for each. Tables A39 and A40 presents a cumulative summary of all parts of this question.

3D printing technology: The data in Table A9 shows that only 8.3% of the participants reported having high level of expertise with 3D printing technology based on the Likert-scale level at 4 or above, while 81% of the response registered a below 3 Likert-scale level.

Research suggest that it is very important for districts to gain sufficient knowledge of this technology as the 3D printing is poised to have a key role in starting the next industrial revolution (Nov, Arazy, & Anderson, 2011). Figure 2, graphically presents the distribution of the responses registered in Table A9, showing that the majority of the responses are skewed to the left suggesting that majority of district Administrators lack the necessary awareness of this important technology to take advantage of what this technology presents as opportunities and potential for pedagogical practices. Lack of district knowledge of this important technology would prevent students the opportunity to invent and innovate, as their growth remains rooted in their experience (Papert, 1993).

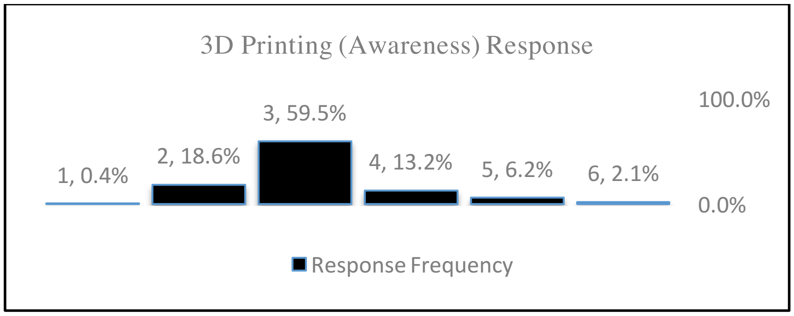

Figure 2. 3D Printing - Response (Likert Scale - *n%*) distribution.

It is important for districts to know that this type of technology is accessible today, and it allows for hands-on problem-based learning within the context of many modern curricular activities (Gershenfeld, 2005; Martinez & Stager, 2014).

3D video technology: Awareness of 3D video technology can help enhance a school district's technology offering. Data in table A10 shows that 41.1% of the respondents have little to no knowledge of this important technology. Figure 3 shows the distribution of the responses to the Likert-type question from the data in Table A10, which shows a skewed distribution to the left that suggests that most of the Administrators lack working knowledge of this technology.

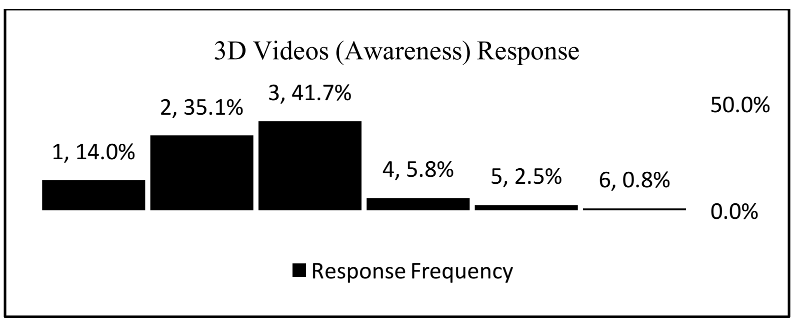

Figure 3. 3D Videos – Response (Likert Scale – *n%*) distribution.

3D video display technology is quickly making its way into classrooms, as this technology continues to gets traction due to affordability and improvements there will be more practical applications of this technology within education like 3D projector to help students visualize things such as the inside of the human body or parts of a cell.

Adaptive learning: Research suggest that district awareness of the emergence of computer-mediated adaptive learning systems that make use of smart software or what is also known as intelligent tutors is very important; these types of systems can be used to augment or replace some of the direct instruction. According to Enyedy (2014), and the ISTE 2016 standards there is an immense push for this technology due to continued advancement of software and computing power of computers for the advancement of teaching and learning. The data in Table A11 shows that 74% of the respondents have at least seen demos of one or more adaptive learning systems in the context of education. Figure 4 represents the data from Table A11 that shows that only 17.4% of the respondents have good working knowledge of this technology as reported at Likert-scale of above 4.

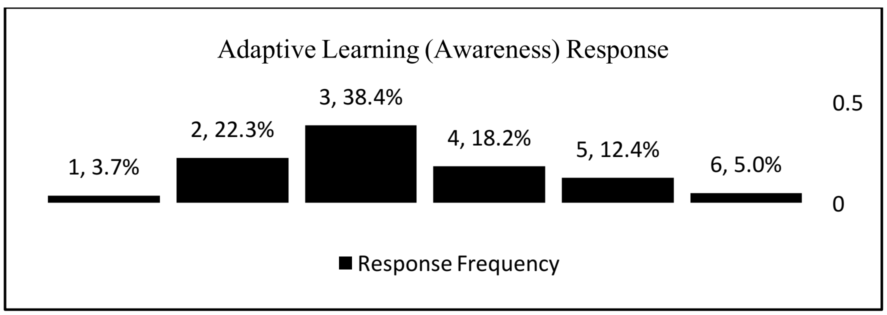

Figure 4. Adaptive Learning – Response (Likert Scale – *n%*) distribution.

Administrators' lack of knowledge of this important technology can deprive the district from accessing affordances that adaptive learning systems can provide. Research further suggest that adaptive learning systems provide effective of individualized learning activities, which paves the way for greater student independence and control over their learning.

Artificial Intelligence: According to the Institute for the Future (2011), in the next two decades, major drivers such as demographic shifts, large data, and smart machines operated by Artificial Intelligent software will transform many aspects of our society. Data in Table A12 shows that more than half, or 52.5%, of the respondents, did not have sufficient knowledge of any AI systems for education. Figure 5 graphically shows the distribution of the responses based on the Likert-scales from Table A12 that is highly skewed to the left with 90.1% of the responses clustered within the first 3 scales.

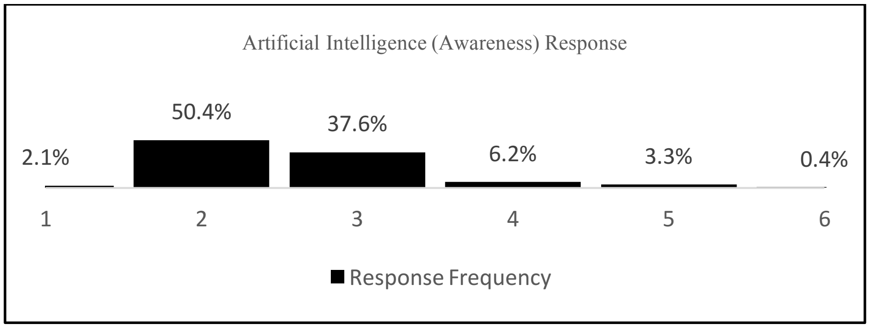

Figure 5. Artificial Intelligence Response (Likert Scale - *n%)* distribution.

According to Timms (2016), Artificial Intelligence is out of the box and is an important consideration for education today. Artificial Intelligent tutoring software can be used in smart classrooms as a modern approach to communication of knowledge (Wenger, 2014). District Administrators' lack of awareness of different AI systems for utilization within the context of their district's curricular and pedagogical practices can be highly detrimental towards their district's quest to improve its technology capabilities.

Augmented Reality: Many researchers suggest that AR technologies that allow for projection of digital materials onto real-world objects can provide learning opportunities in ways that were not possible before (Azuma, 1997). AR type technologies can have enormous potential in improving teaching and learning outcomes (Bower et. al, 2014). Data in Table A13 shows that 60.3% of the respondents have basic or no knowledge of AR.

Figure 6 shows the distribution of the responses to the Likert-type question from Table A13; the data is skewed to the left that shows that less 7% of the respondents reported to have good understanding of what AR technology represents in the context of their work.

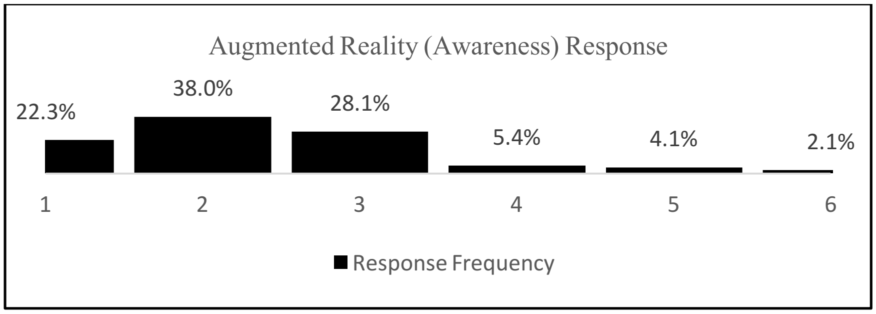

Figure 6. Augmented Reality Response (Likert Scale - *n%*) distribution.

The data from the survey suggests that district Administrators have a lot learn about this technology to allow for their students the experience of imagining the world through a virtual overlay and to be completely immersed in an artificial environment where computer-generated objects coexists within the real-world environment, and students using text, animation, images, videos, sound, and 3D models can improve their learning.

Bring Your Own Device (BYOD): As cost of personal computing devices continue to decrease, it is important that districts start using strategies to improve student access to computing devices; one such strategy is to encourage students to bring their own devices also known as Bring Your Own Device (BYOD) until districts reach 100% saturation of their own 1:1 device implementation. The data in Table A14 shows that 28.9% of the respondents reported having basic to no familiarity with the concept of BYOD.

Figure 7 shows the results of the distribution of the six Likert-type scales from Table A14. The distribution shows that 22.3% of the respondents have never heard of BYOD, while 62.8% reported that they at least have heard of the BYOD strategy.

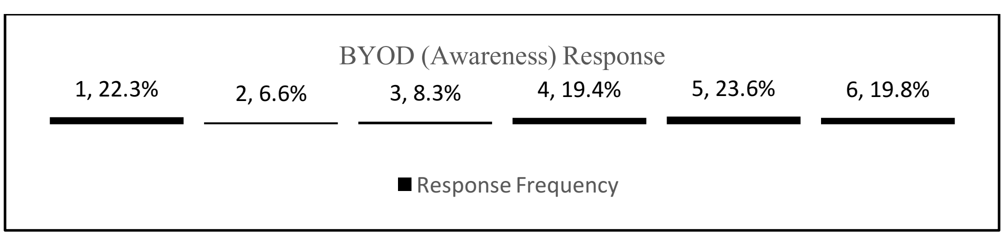

Figure 7. Bring Your Own Device (BYOD) Response (Likert Scale - *n%*) distribution.

The awareness of this strategy will allow for districts to capitalize on the excitement that is created by the many Internet technologies and reach a wider audience saturation of students and teachers. This strategy also allows for better and seamless classroom activities such as Science inquiry (Song, 2014).

Cloud computing: District's use of cloud computing as a strategy can help reduce the digital divide, and while cloud computing promises to improve overall network efficiency, scalability, and the reliability of much educational software within existing district hardware resources (Kurbel, 2001). Data in Table A15 shows that 22.3% of the respondents either did not know about cloud computing or had a basic understanding of it.

Figure 8 shows the distribution of the data from Table A15, which 77.3% of the respondents have reported as having some or good understanding of cloud computing.

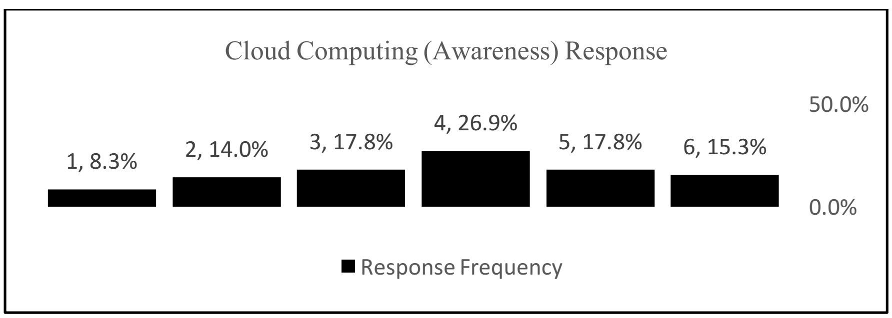

Figure 8. Cloud Computing Response (Likert Scale - *n%*) distribution.

Research suggest that it is beneficial for districts to know that cloud computing enables ubiquitous, easy, and on-demand network access, which allows for the district to share and customize its computing and academic resources (Mell & Grance, 2011). Many districts are already using available cloud services, such as Google Apps for Education (GAFE) and Office 365 from Microsoft, to enable their students and teachers while reducing their overall IT expenditure and the deployment time. Cloud technologies will continue to improve and grow in a positive direction (Johnson et al., 2012).

Coding: Research suggest that many of the jobs of the future require coding skills as students are embarking on emerging topics like Nano-computing, bio-computing, quantum computing, and so many others that require a high level of computational thinking and digital literacy. Data in Table A16 shows that 79.6% of the respondents have at least seen demos of coding within the context of education.

Figure 9 shows the distribution of respondent's answers to the Likert-type question; only 14.9% of the respondents reported to have high-level of knowledge regarding the subject of coding.

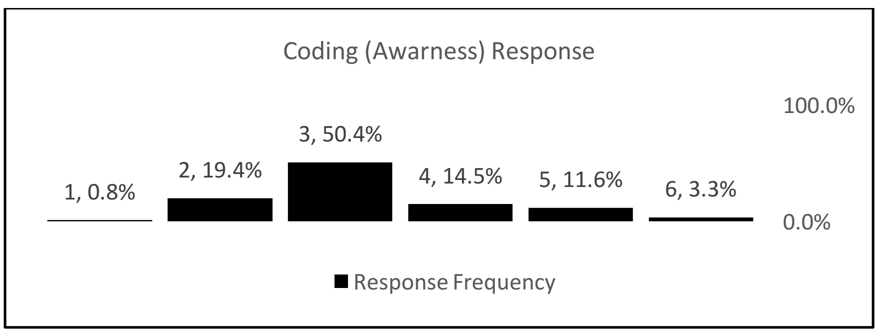

Figure 9. Coding response (Likert Scale - *n%*) distribution.

Districts need to prepare young children as early as Pre-K by using curricular material that gives students the opportunity to interact with robotics and complex systems that require coding knowledge to program one or more sets of logical instructions. Coding through computer science curricular material can help support a multitude of academic goals (Kalelioğlu, 2015).

Computational thinking: Many researchers emphasize the importance of computational thinking and suggest that computational thinking is necessary to ready students for many requirements of emerging academic topics. The data in Table A17 shows that 29.8% of all respondents have never heard of computational thinking.

Figure 10 shows the distribution of responses captured in Table A17 to be highly skewed to the left as only 7.4% of the respondents reported to having good understanding of computational thinking.

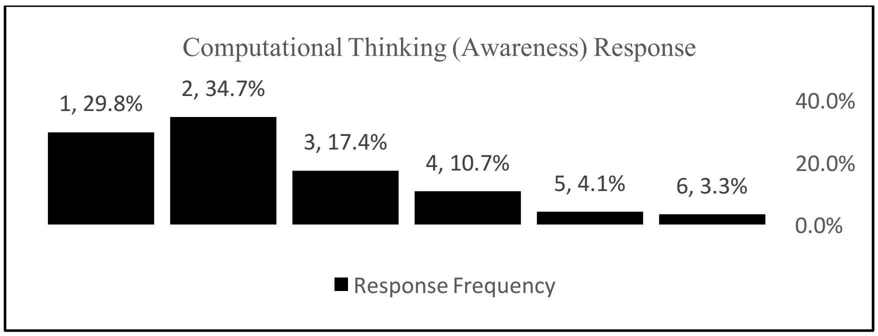

Figure 10. Computational thinking response (Likert Scale - *n%*) distribution.

Districts need to realize that students need to increase their computational thinking capabilities to succeed in the modern society (Wing, 2008). The data from this study suggest that majority of the district Administrators need to learn more about computational thinking and its implication for their district's use.

Crowdsourcing: Emerging strategies such as crowdsourcing allow for deeper and more meaningful online learning with opportunities to access wide collaborators and knowledge base across the globe (Porcello & His, 2013). The data in Table A18 shows that 54.6% of district Administrators have little to no understanding of strategies for crowdsourcing.

Figure 11 represents the frequency distribution data from Table A18, which shows that the distribution is highly skewed to the left where only 11.1% of the respondents reported to have adequate knowledge of crowdsourcing strategy.

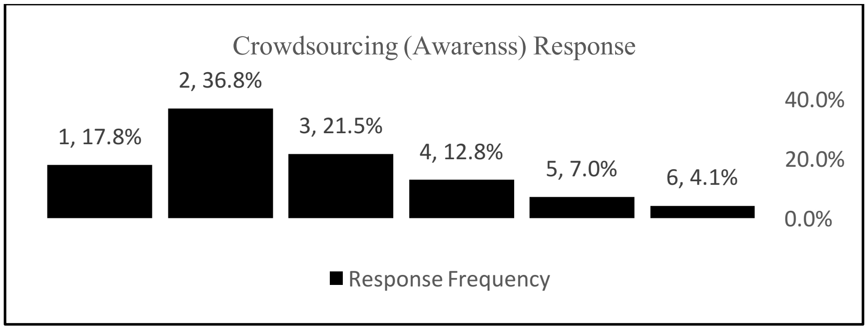

Figure 11. Crowdsourcing response (Likert Scale - *n%*) distribution.

A District Administrator's awareness of the importance of crowdsourcing can vastly improve implementation of modern curricular and pedagogical practices. The data from this study suggest that only 11.1% of the respondents have good working knowledge of this important strategy.

Data analytics: Districts efforts to include curricular opportunities for data analytics is becoming more important than ever before according to research. Data in Table A19 shows that 43.3% of the respondents reported knowing the use of data analytics without any help; however, 56.6% of the respondents reported to not having sufficient knowledge of how to use data analytics in the context of their work.

Figure 12 shows distribution of responses from Table A19, which is skewed more to the left.

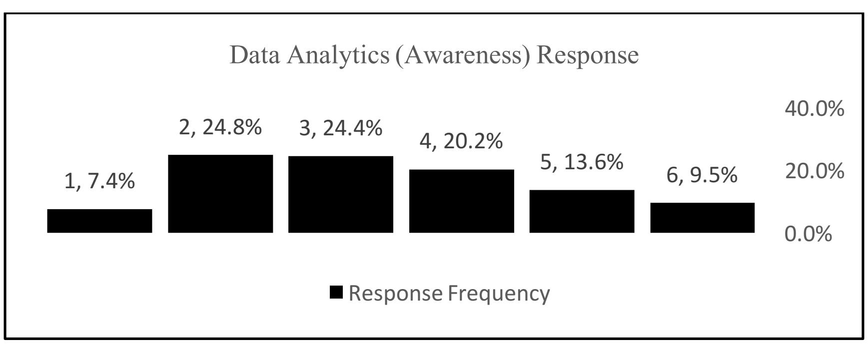

Figure 12. Data Analytics Response (Likert Scale - *n%)* distribution.

Within academic circles, it is suggested that student through data analytics can make more-informed decisions about scientific results, models, theories, and hypotheses, therefore, based on this study it is important that districts improve their understanding of what data analytics mean for their district's curricular and pedagogical practice; additionally, the data suggest that districts need to find ways to improve their administrator's knowledge of this strategy.

Digital badges: Research suggest that digital age students are intensely involved in online activities, and as such, strategies such as digital badges or microcredits can be used to improve student engagement with many curricular and pedagogical practices through validation of accomplishments (Gibson et al., 2015). The data in Table A20 shows that 43.8% of the respondents reported having little to no knowledge of digital badges, while 14.9% of the respondents reported having a good understanding of what it was. Figure 13 shows the distribution of responses from Table A20, which is skewed to the left.

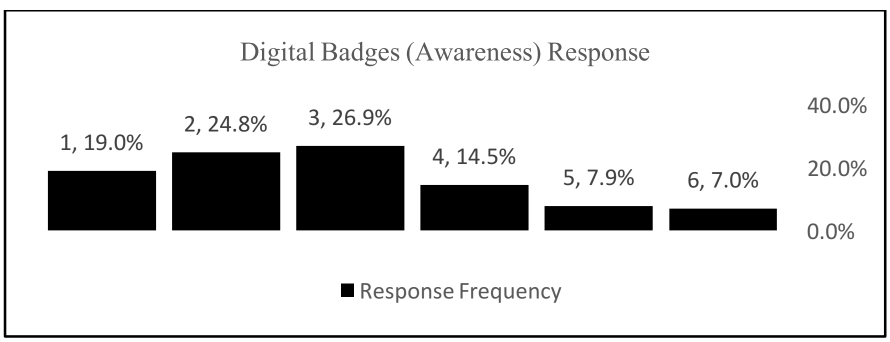

Figure 13. Digital Badges Response (Likert Scale - *n%)* distribution.

The data from this study further suggests that most of the district Administrators lack working knowledge of digital badges, which can limit online involvement for curricular application and student engagement.

Flipped classrooms: As many school districts are working on ways to add alternative programs to their existing traditional brick-and-mortar model, according to research flipped classrooms is a major consideration, which is an instructional strategy that reverses the traditional learning methodology by offering most of the instructional content online and gives the students an opportunity to do their homework assignments in class under the supervision of their teachers (Lo & Hew, 2017). Data in Table A21 show that at least 93.7% of the participants reported to at least have heard of flipped classroom strategy. Figure 14 shows the distribution of responses from Table A21.

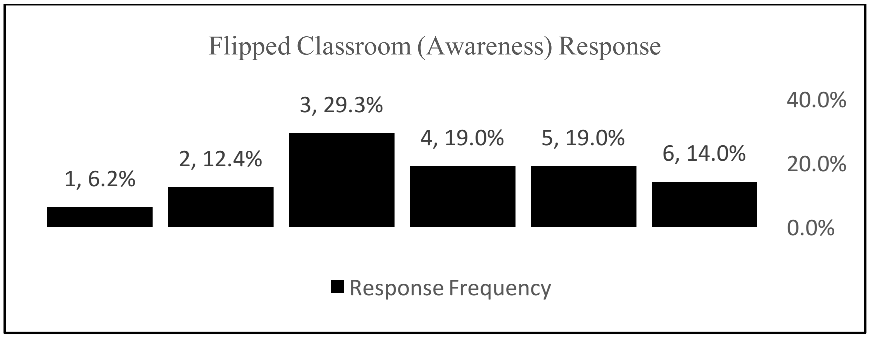

Figure 14. Flipped classroom response (Likert Scale - *n%)* distribution.

School district's awareness of flipped classroom strategy may help extend academic programs across the district and help retain some of those students that no longer want to subscribe to the traditional model of brick-and-mortar.

Information visualization: It is widely known in many academic circles that with the updated content standards and emerging topics in education, information visualization technologies are quickly advancing and is becoming more relevant into the mainstream classrooms. Today, there are many software and strategies to allow for visualization of information (Steichen, Carenini, & Conati, 2013). The data in Table A22 show that 64% of the respondents reported having little to no familiarity with information visualization technologies. Figure 15 shows the distribution of the responses from Table A22, which shows that the data is highly skewed to the left.

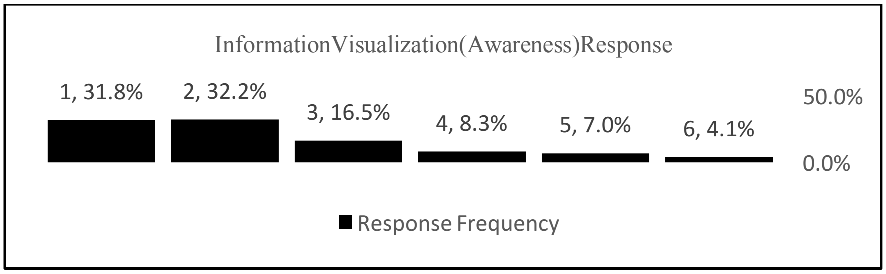

Figure 15. Information visualization response (Likert Scale - *n%)* distribution.

Districts need to be aware of data visualization technologies that can vastly improve curricular and pedagogical activities in many applications from Mathematics to Science. The results of this study suggest that majority of district Administrators lack the basic knowledge necessary to increase utilization of technologies that are used for data visualization.

Internet of things: The Internet of Things takes into account devices other than the standard computer or the smartphones that students typically use to access the Internet or information. Data in Table A23 shows that 59.9% of the respondents reported that they have little to no familiarity with the technologies associated with the Internet of Things.

Figure 16 shows that the data from Table A23 is skewed to the left.

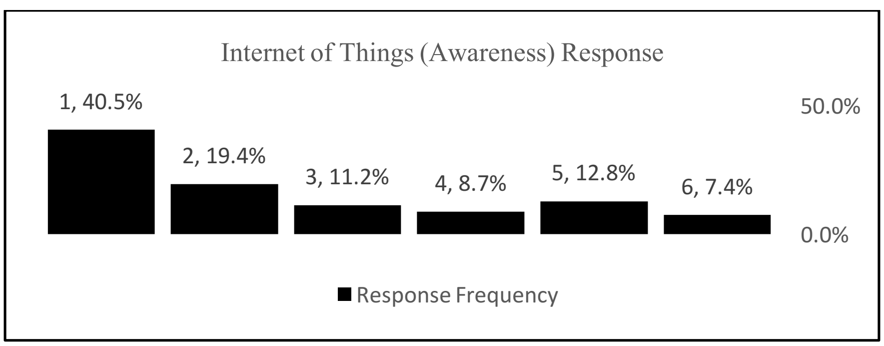

Figure 16. Internet of things response (Likert Scale - *n%)* distribution.

There are a growing number of applications within K-12 related to the Internet of Things, from campus safety to keeping track of resources. As students are moving away from using the traditional paper towards digital means such as mobile computing devices, or an interactive appliance with embedded electronics and software for sending and receiving data, the idea of the Internet of Things is continually surfaces and is becoming a necessity in a modern classroom (Castells, 2011). The data from this study suggest that 4 out of 5 district Administrators do not know enough about Internet of Things to effectively use that knowledge to improve technology utilization for their district.

ISTE standards: ISTE education technology standards are designed to empower today's connected learners with the use of technology through research-based methodologies (ISTE, 2016). The data presented in table A24 shows that 47.1% of the respondents reported to have little to no familiarity with the ISTE standards. Figure 17 shows the distribution of the responses to the Likert-type question, which shows the distribution of the data to be skewed to the left.

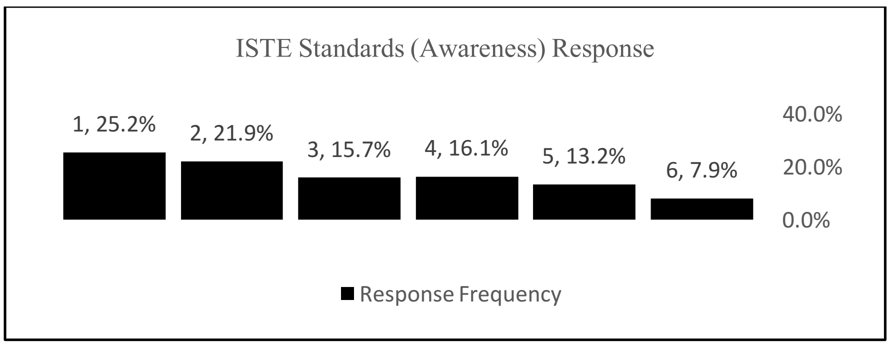

Figure 17. ISTE standards response (Likert Scale - *n%*) distribution.

According to research awareness of ISTE standards is an important consideration that all district Administrators need to have familiarity with as there is positive correlation between their level of familiarity and their ability to effectively implement technology with their curricular and pedagogical practices for their district.

Learning analytics: According to research learning analytics is a critical component of the teaching and learning processes (Gašević, Dawson & Siemens, 2015). The data in Table A25 shows that 57.4% of the respondents surveyed indicated little to no knowledge of technologies associated with learning analytics. Figure 18 shows the distribution of the data from Table A25, which shows that 11.6% of the respondents reported to have good knowledge of technologies that facilitate learning analytics.

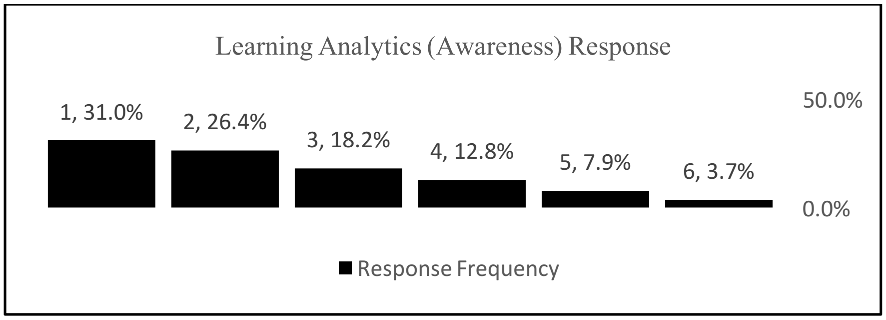

Figure 18. Learning analysis response (Likert Scale - *n%*) distribution.

As technologies that assist with learning analytics become robust and available, districts need to take advantage of the affordances that these technologies offer to improve teaching practices and student performance. The data from this study suggest that majority of district Administrators need to learn more about technologies that provide learning analytics for their teachers and students.

Learning management software (LMS): Many studies suggest that LMS software is an important tool for districts that allow for more effective deployment of online lessons. Table A26 shows that 66.9% of district Administrators that were surveyed reported that they had little to no familiarity with an LMS. Figure 19 shows the distribution of the data from Table A26, which is highly skewed to the left, suggesting that there are many respondents that don't know much about this technology.

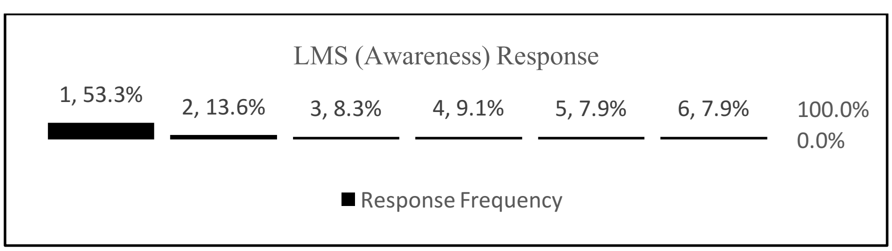

Figure 19. Learning management system (LMS) response (Likert Scale - *n%*) distribution. In recent years there has been a notable increase in the percentage of schools that use online instruction;

online lesson delivery is more manageable using an LMS (Christensen & Horn, 2008). Data from this study suggest that only a small percentage of Administrators have sufficient knowledge about LMS that can be useful for their district.

Location intelligence: Many curricular activities require students to be able to derive meaningful insights from geospatial relationships that most data contain. Data in Table A27 shows that 76.8% of Administrators indicated that they have little to no understanding of location intelligence. Figure 20 shows the frequency distribution of the data from Table A27, which shows that only 4.6% of the respondents had good working knowledge of location intelligences technologies for use in education.

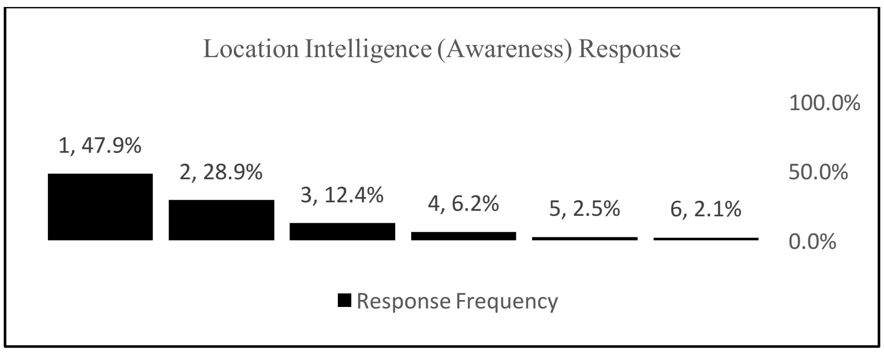

Figure 20. Location Intelligence Response (Likert Scale - *n%*) distribution.

Research suggests that it is very important for district Administrators to be familiar with the types of technologies and software that can help students use location intelligence for spatial analytics to understand the relationship between objects concerning spatial data and be able to perform a wide range of required numerical and analytical analysis.

Machine learning: Many adaptive learning systems and smart tutors are benefiting from machine learning from its optimization of analytics to improve performance of systems and software in the context of use for teaching and learning. Data in Table A28 shows that 78.5 percent of the respondents indicated that they have little to no knowledge of machine learning.

Figure 21 shows the distribution of the responses from Table A28, which also shows that only 3.7% of the respondents knew of machine learning.

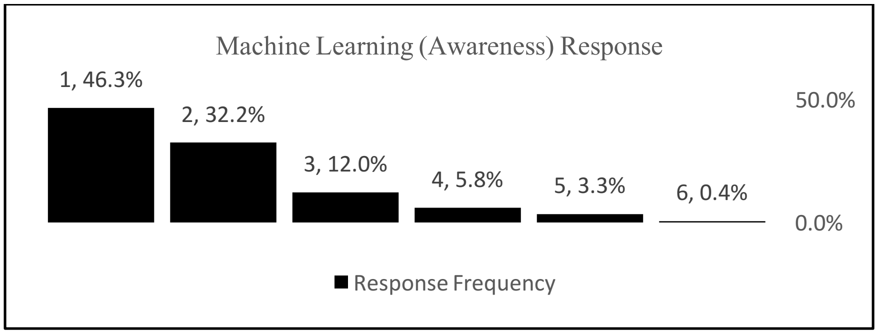

Figure 21. Machine learning Response (Likert Scale - *n%*) distribution.

Data from this study shows that most districts have limited knowledge of this technology, as today, the rapid advancement in computing technologies is providing systems for education that uses machine learning to provide tools for content analytics, learning analytics, dynamic scheduling, smart grading, predictive analytics, and data mining to name just a few.

Mobile/handheld computing: It is widely known that students today are taking advantage of their mobile devices, and as such, these devices are becoming a necessity in modern classrooms (Castells, 2011). Data in Table A29 shows that 82.7% of the respondents have at least heard about what a mobile or handheld device is. Figure A22 shows the data from Table A29, which also shows that 17.3 % of the respondents had little to no understanding of mobile or handheld computing technologies or strategies for their work.

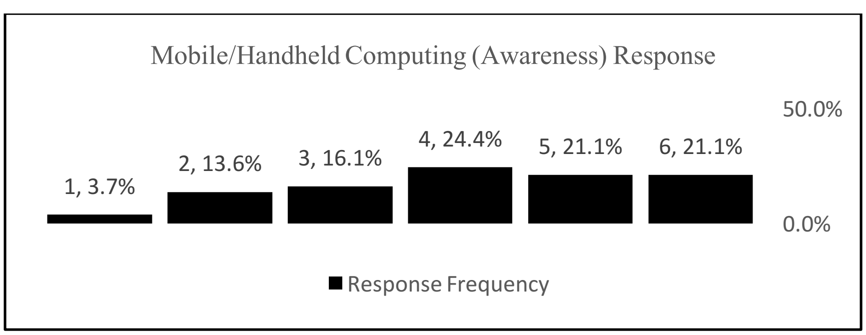

Figure 22. Mobile/Handheld Response (Likert Scale - *n%*) distribution.

It is also common knowledge that most students own or can operate a mobile computing device. Lenhart (2015) cited a survey by Pew Research Center that more than 90% of teens that navigate the Internet do so by using some type of a mobile device like their smart phone. The data from this study also show that a very small percentage of district Administrators reported to be unaware of this technology, however, approximately 1 in 5 Administrators reported limited awareness of this technology.

Online learning: Online learning due to recent advances in network infrastructure is providing opportunities for school districts to expand their offerings to meet the growing need for online education. Data in Table A30 shows that 100% of all participants have reported having at least heard of what online learning is. The data also shows that 59.9% of the participants reported having an elevated level of understanding online learning technologies or strategies. Figure 23 shows the data from Table A30; the data shows that only 3.3% of the respondents reported to not have heard or knew about online learning.

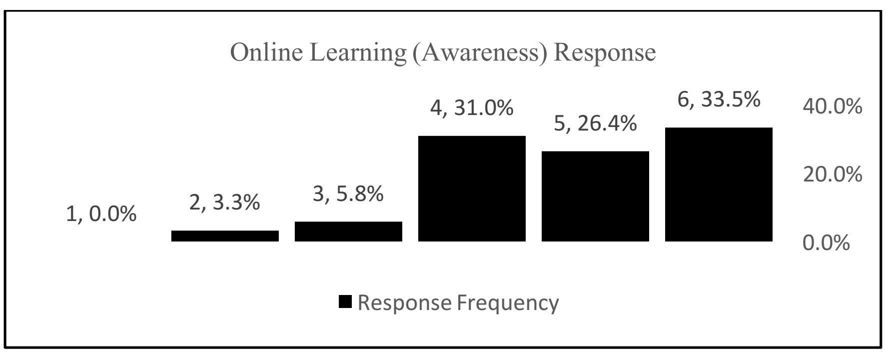

Figure 23. Online Learning Response (Likert Scale - *n%*) distribution.

As the data from this study suggest, many districts have found applications of online learning as such uses include mitigation of student dropouts and support for credit recovery efforts (Ferdig, 2010b). District's knowledge of online learning should also include plans for what it takes to support their teachers, including the provision for the network infrastructure that can support online learning that are critical components for what it takes to make any online learning model successful (Murphy et al., 2014).

Open source hardware: Open source hardware allows students the opportunities for experimental development and tweaks existing hardware to extend capabilities and applications in new and innovative ways. The data in Table A31 shows that 66.1% of respondents have little to no understanding of what open hardware is. Figure 24 shows the data from Table A31, which also shows that only 7.8% of the respondents reported to having good working knowledge of open hardware.

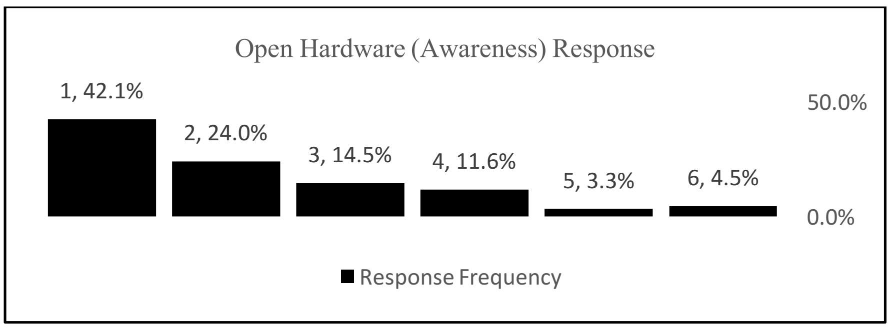

Figure 24. Open hardware response (Likert Scale - *n%*) distribution.

Data from this study shows that districts need to know more about open source hardware, which this technology can aid the students in sharing their ideas and build on ideas and concepts that others have already started.

Robotic technologies: Robotic technologies have garnered lots of attention in recent years. Data in Table A32 shows that 90.5% of the respondents have at least heard of robotics in education. However, only 7.0% of the respondents indicated to have good working knowledge of robotic tools for education. Figure 25 shows the data from Table A32 that shows the data distribution to be skewed to the left.

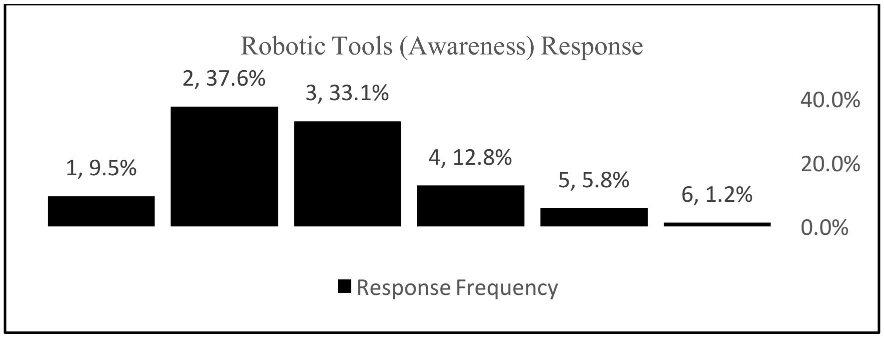

Figure 25. Robotic Tools Response (Likert Scale - *n%)* distribution.

Data in this study shows that districts need to improve their knowledge of this technology as humanity is on the brink of mainstreaming humanoid robots to assist humans from complex to simple tasks including those that require an emotional response. Research suggest that district awareness of robotic technologies can help facilitate opportunities for students to learn about various robotic technologies and application, and give students opportunities to pause and ask deep questions about how devices work and how they can fix them. Children now realize that technology is ubiquitous and is involved in many aspects of their everyday lives, therefore, district awareness of robotic technologies can greatly enhance a school district's technology offering.

Social networks: It is now common knowledge that social media is much more than Facebook and Twitter. Students are using social media as an opportunity to connect with people across the globe to collaborate and participate in virtual communities. Data in Table A33 shows that 99.2% of the respondents have at least heard of social networks, and 59% of the respondents reported high knowledge of the topic. Figure 26 shows the data from Table A33 that shows the distribution of the data to be skewed to the right.

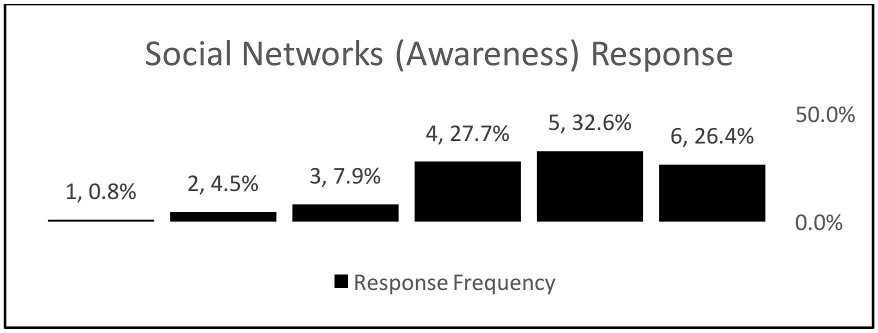

Figure 26. Social Networks Response (Likert Scale - *n%*) distribution.

Data from this study shows that a large percentage of district Administrators reported awareness of Social Networks, therefore, through social networks, district can open to their students access to a worldwide network of users and information databases of all types; information in and of itself is becoming the primary source of value in society (Castells, 2011). Districts need to integrate within their digital citizenship policy mechanisms for students to safely participate in social network activities, therefore, district Administrators' knowledge of this technology for use within their setting is very important.

Virtual laboratories: Virtual laboratories are creating many opportunities for education due to improved software, hardware, VR, and greater network bandwidths. The data in Table A34 shows that 42.1% of the Administrators reported as having little to no understanding of what a virtual laboratory is. Figure 27 shows the distribution of the data from Table A34, which also shows that 13.6% of the respondents reported to having good working knowledge of technologies that facilitate virtual laboratories for their district.

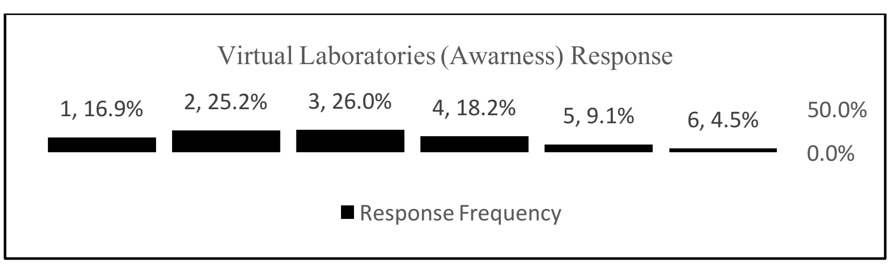

Figure 27. Virtual Laboratories Response (Likert Scale - *n%*) distribution.

Virtual laboratories are safe and relatively more cost-effective as they can help facilitate many complex experiments that are typically not possible within the physical or time constraints associated with a traditional physical laboratory. District Administrators' awareness of virtual laboratories is important as planning and implementation require leadership to facilitate extending uses of VR technology to advance student learning.

Virtual reality (VR): VR allows students to participate in experiential learning opportunities through simulation of real-world environments. Data in Table A35 shows that 31.8% of the respondents reported to having little to no knowledge of virtual reality. Figure 28 shows the data for Table A35, which also shows that 14.5% of the respondents reported to having good working knowledge of some virtual reality technologies or applications for their district use.

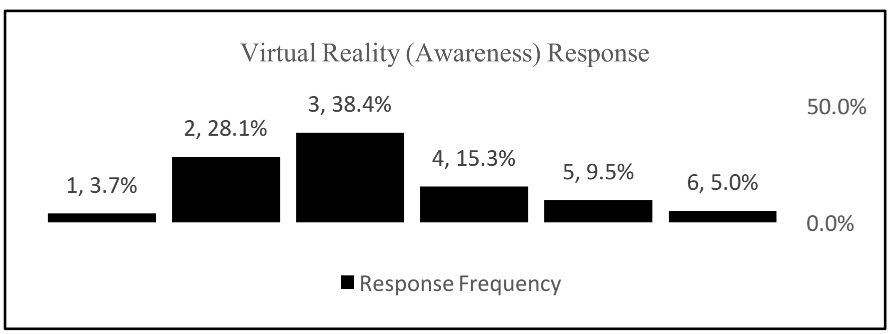

Figure 28. Virtual Reality Response (Likert Scale - *n%*) distribution.

According to ISTE 2016, a sizable percentage of teachers are interested in making VR part of the learning experience for their students. The data from this study show that district Administrators need learn more about VR, as teachers today can use VR to make many course contents more accessible like conducting virtual chemical reactions, flying a plane, trading stocks on the floor of a stock exchange, travel to distant landmarks, and even exploration of volcanos or space becomes a possibility. VR software is also improving rapidly, and the cost of implementation for districts is getting cheaper.

Visual Data Analysis: As technology continues to advance, the amount of data that is produced is also on a similar trajectory and is increasing in unprecedented rate. Data in Table A36 shows that 56.6% of the respondents reported to having little to no knowledge of what virtual data analysis is. Figure 29 shows the data from Table A36, which also shows only 11.6% of the respondents reported to have good working knowledge of visual data analysis technologies of strategies.

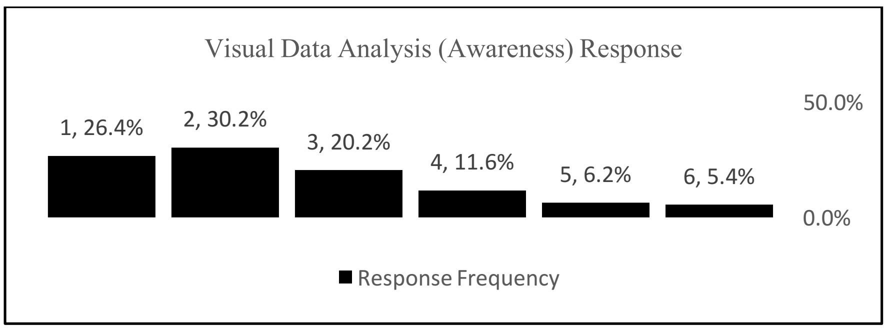

Figure 29. Visual Data Analysis Response (Likert Scale - *n%*) distribution.

Research suggest that school districts needs to know about technologies that allow for virtual data analysis, as these technologies allow for decision makers to quickly uncover information that is normally concealed in data that is often massive, heterogeneous, and dynamic. Virtual data analysis allows for students to make judgments of data-models that software turns into visual representations, which is an important skill that students need to acquire for handling data and encourage virtual data analysis within the curricular and pedagogical practices of their district while supporting technologies and software to help with those efforts.

Volumetric/holographic display: Advances in 3D display technology that are also known as holographic or volumetric displays is making this technology affordable and accessible for classroom use. Data in Table A37 shows that 77.7% of the respondents have little to no knowledge of this technology. Figure 30 shows the data for Table A37, which also shows that .8% of the respondents had working knowledge of volumetric or holographic display technologies used for education.

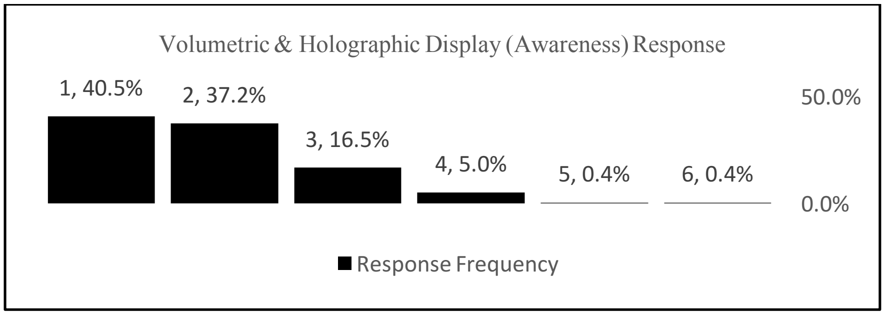

Figure 30. Volumetric & Holographic Display Response (Likert Scale - *n%*) distribution.

The data from this study show that most Administrators reported having little to no knowledge of this technology, as this technology affords many practical applications within education like a 3D projector that can help students visualize the inside of a cave or parts of the human body.

Wearables: As the movement towards digital augmentation continues to advance, research suggests that wearable technologies continue to permeate into many uses within the context of teaching and learning. The data in Table A38 shows that 62.8% of the respondents reported having little to no knowledge of wearables.

Figure 31 shows the data for Table A38, which also shows that 10.4% of the respondent as having working knowledge of wearable technologies.

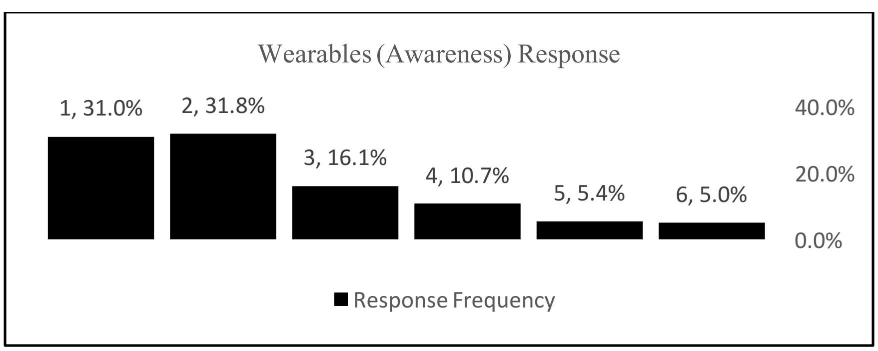

Figure 31. Wearables Response (Likert Scale - *n%)* distribution.

Wearable technologies include devices such as Google Glass, Fitbit, and Oculus Rift, which are examples of devices that are available today, and each with their own sophisticated onboard analytics and interface allows for a wide range of opportunities to benefit curricular and pedagogical application in education. The debate about the use of wearable technologies continues, however, district Administrators should explore and be knowledgeable about the potential educational uses.

Overall Response to technology awareness: To get an overall understanding of the results that was captured within Tables A9 through A38, and the data is summarized and sorted by knowledge level from none to expert in Table A39.

To further analysis the data, Table A40 reflects a consolidation of the six Likert-scales that was originally used to capture survey data into 4 specific knowledge levels (None to Very Low, Low, Moderate and High to Very High).

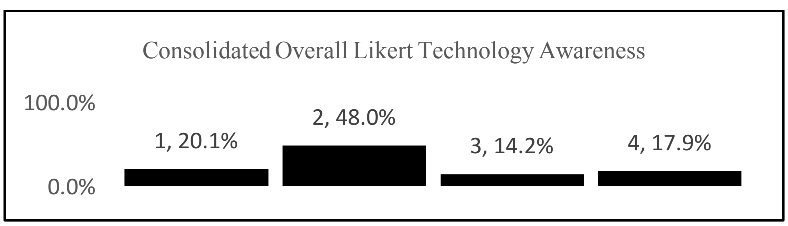

Figure 32. Consolidated overall technology awareness response.

The data in Table A40 as well Figure 32 reflects an overall average of the consolidated columns of data from Table A41, which shows that 68.1% of the respondents reported to have (None to Very Low) level of working knowledge of the technologies that were surveyed about. The data also shows that 14.2% of the respondents reported to having only (Moderate) level of awareness of those technologies, while 17.9% reported to having (High to Very High) level of working knowledge of the technologies that was surveyed about within the context of their work. The overall technology awareness data suggest that school districts need to consider professional development for their Administrators as most of the Administrators do not have enough working knowledge of the various existing and new technologies to be able to lead their district's technology plan in the right direction.

Technology knowledge acquisition

To gain additional insights for the purpose of answer research question I, respondents were also asked to provide answers to the following questions.

1. Which professional organizations, if any, do you belong to? (if none, write none).
2. Which job related professional conference(s), if any, have you attended within the last year? (if none, write none).
3. Which job related professional training(s), if any, have you received in the past year?

The survey data for question 1 is shown in Figure 33, which indicates that 20.5% of 242 participants did not report any membership to any professional organization.

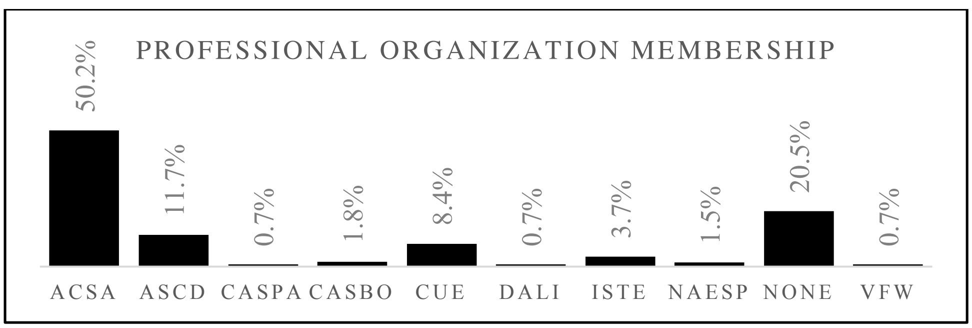

Figure 33. N = 242, Professional organization membership (*n%*).

The data further shows that 12.1% of the respondents reported being members of ISTE and CUE, which are organizations that are highly focused on applications of education technology. Furthermore, the data in Figure 33 shows that 67.4% of the organizations that are listed do not focus on technology.

The survey data for question 2 is shown in Figure 34, which indicates that 32% of the respondents did not attend any professional conference within the past one year.

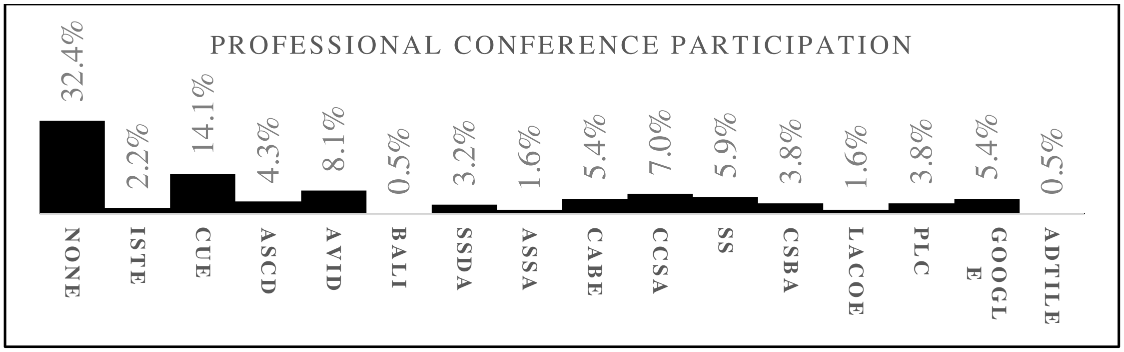

Figure 34. *N* = 242, Professional conference participation (*n%).*

The data also shows that 21.7% of respondents have participated in technology conferences such as ISTE, CUE, and Google-for-Classroom; additionally, 46.3% of the conferences that were reported are not technology focused conferences. The data for question 3 is shown in Figure 35, which shows that 22.4% of the respondents reported that they did not have any job related professional training within the year.

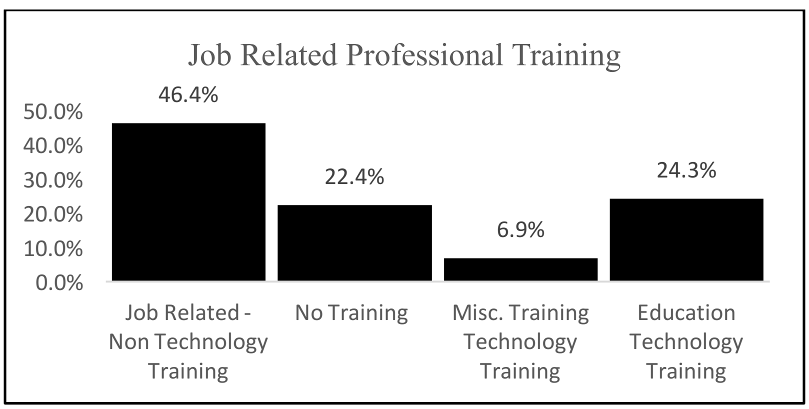

Figure 35. *N* = 242, Job related professional training (*n%*).

The data also indicate that 46.4% of the training that respondents participated in were job-related. However, those trainings were primarily for general administrative and operation duties that did not relate to any aspects of technology; additionally, the data shows that 31.2% of the participants reported to have received technology-related training that was essential for their job function.

Familiarity with digital strategies and maker movement

As school districts' technology implementation progress forward, district Administrator's understanding of popular digital strategies such as digital citizenship is critical to the process of district technology implementation according to ISTE 2016 and other research. The survey asked respondents to provide answers to questions that are directly related to their expertise in digital citizenship, content curation, blended learning, the maker movement, and global citizenship; and these factors are critical aspects of technology implementation according to ISTE 2016 technology standards. Using Likert-type questions with six scales, Table A41 shows the results of the survey questions that have captured participants' reported level of knowledge with regards to digital strategies that they were asked about.

To make the data more usable for discussion, the data is further consolidated and displayed Table A42, which shows that 35% of the respondents have reported to having no to low level of knowledge of the 5 digital strategies that were surveyed, while 36.6% of the respondents reported to having low to moderate level of knowledge; additionally, only 28.5% reported as having high to very high level of knowledge regarding the strategies.

Technological knowledge (TK)

The data in Table A43 shows responses to 9 dichotomous questions designed to measure technological competency as it relates to the intermediation between curricular and pedagogical practices. The data represents the responses from an average of 219 respondents for the nine questions that were asked. The data in Table A43 shows that 89.5% of the respondents answered yes, which indicates that they can use the technology that they were asked about, while 10.5% answered that they are not able to use the technology that they were asked about.

Technological pedagogical knowledge (TPK)

The data Table A44 reports on the results of the questions regarding Administrators' pedagogical skill competency. This section of the survey asked ten dichotomous yes/no questions about respondent's ability with regards to their pedagogical skills used along with technology and curricular activities. Data shows that 86.6% of the 190 respondents indicated "yes" for having the pedagogical knowledge, and 13.4% indicated that they did not.

Technological curriculum knowledge (TCK)

The data in Table A45 reports on the results of the questions regarding Administrators' curricular expertise with the intermediation of curricular activities with technology and pedagogy. This section of the survey asked ten dichotomous with yes/no answers. The data shows that 81.8% of the 230 respondents indicated "yes" and 13.4% reported "no."

The data in tables A43 through A45 provided insight as to what the level of knowledge related to TPACK components (TK, TPK, TCK) of district Administrators. The data indicates that on average 86% of the respondent reported as having a working knowledge of when, where and how to use specific technologies applications within the context of the TPACK framework that were asked about, while 14% of the respondents reported limited knowledge.

It was also important to the study to know which technology implementation framework Administrators were familiar with. Participants were asked an open ended question: If you are aware of a theoretical framework for technology implementation, if any, please describe it below. (if none, write none). Table A49 provides the data captured and carefully coded from the 242 respondents, which show that 7% of the respondents reported to have familiarity with SAMR, 3% with TPACK, and 53% indicated that they did not know any framework for technology implementation. The data also shows that 36% of the respondents declined to provide any answer to the survey question.

Implementation of technology according to ISTE 2016 standards require a framework such as the TPACK, which provides the bases for educators to continually see the intermediation between technology, pedagogy and curriculum; this understanding will allow district Administrators to think about the importance of not just how a certain technology is used by the teachers in the classroom but also about when and where technology is used correctly.

Curriculum standards familiarity and training: Research suggests that it is important that District Administrators also be knowledgeable about the current Common Core State Standards in Mathematics, English, as well as the NGSS Science Standards. The survey asked Administrators to rate their knowledge of the current curriculum standards, the data Tables A46 and 47, along with Figure 38 show the results.

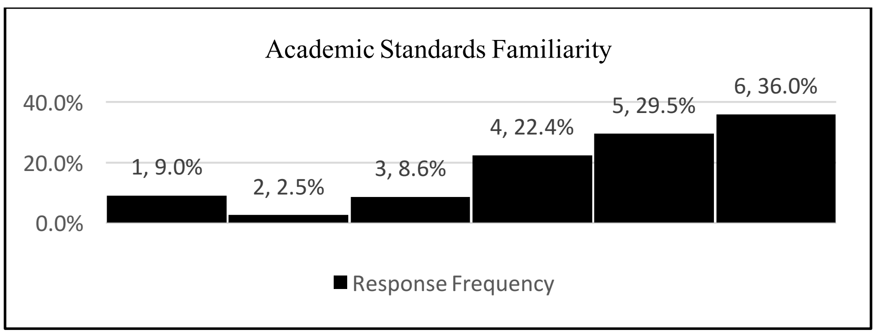

Figure 36. N = 242, Academic standards familiarity (Likert Scale - *n%*).

The data from Table A46 is consolidated in Table A47 that is also to give a more a clearer insight as to the findings.

The data in Table A47 shows that 11% of the respondents reported that they did not have any familiarity with the standards such as Common Core, NGGSS, or any other. The data also shows that 82% of the respondents have had some type of familiarity for one or more standards, while 7% declined to answer the survey question. Participants were also asked about which content standards they were formally trained on. The data in Table A48 show that only 11% of the respondents did not receive any training while 82% stated to have received training for at least one of the standards. The last part of the survey asked participants to answer 9 questions regarding constrains, supports, problems, or issues related to policy and practice that they perceive would impact their district's ability to plan, budget and adopt technology. Each question is followed by the descriptive analysis of the data captured from survey.

Obstacles that impede technology implementation

Question: Which constraint(s), if any, may limit technology implementation? (if none, write none). The data is presented in Table A49 shows that respondents reported 54% due to funding, 30% due to infrastructure, and 42% due to training as the main constraints that impede their ability to effectively implement technology for their district, while 9% of the respondents declined to answer the question.

Question: Which type of internal support(s), if any, assist(s) with technology integration? (if none, write none). Data in Table A49 show that respondents reported that support comes from a wide range of resources. The largest source for support was identified as the IT department followed by school staff 16.9%.

Question: Which policy problem(s), if any, impede your ability to plan for technology? (if none, write none). Data in Table A50 shows that 45% of the respondents did not see any problems, while 55% of the respondents reported that there were problems with budget, district policy, hardware, IT, lack of training, network connectivity issues, parents, students, teachers, time, vetting process for hardware and software, and the district's internal firewall for web filtering.

Question: Which policies and/or practices, if any, impede your ability to adequately budget for technology. Data in Table A51 in Appendix shows that 43.9% of the respondents did not see any obstacles for their ability to adequately budget for technology, however, 56.1%

reported that training for technology, district budget, local or state funding like LCFF, grants, general funding, and district's fiscal policy impede their ability to adequately budget for technology.

Question: Which polices and/or practices, if any, impede your ability to increase technology utilization or adoption? The data in Table A52 show that 37.1% of the respondents do not see their district's policy or practice as an impediment to increasing technology utilization or adoption; however, 62.9% of the respondent attribute policies or practices that relate to such things as training, teachers, lack of resources, funding, etc., as impeding factors for technology utilization or adoption.

Question: How much per student does your district spends on technology annually? The data presented in Table A53 shows that 78.3% of the 217 respondents reported that they do not know how much per student the district spends on technology. The data in Table A54 shows that 21.7% of the respondents reported that on average, their district spends $289.57/student. The median for data was 200.00 with standard deviation of the spending average was reported at $289.57 per student with a Median of $200.00 expenditure per student.

Question: What is your district's network connection for supporting data transfers (bandwidth in Gbps)? The data in Table A55 shows that over 70% of the respondents were unable to provide an answer for their district's network and Internet speed. Upon review of the data and from the small percentage of the respondents that were able to provide answers, most of the answers were not meaningful, therefore, the results were not considered significant to be used in this study. Respondents were also asked about Internet reliability; Table A55 shows that over 90% of the respondents reported to have reliability Internet connectivity through their district's network infrastructure.

Question: Does your district have a current technology plan? The data in Table A56 reports that 19.3% of the respondents indicate no knowledge of a district technology plan for their district, while 80.7% said that their district have some type of a plan.

Question: If your district has a current technology plan, was it written by a consultant? Data in Table A57 shows that 81.01% of the 179 respondents that answered the survey question reported that their districts did not write their own technology plan. The data also shows that 6.15% reported that their district develops their plan in house, while 12.85% marked "other" for their answer.

Question: Which government (Federal or State) funding, if any, does your district receive to support its technology program? (if none, write none). The data in Figure 37 indicates that 44.2% of the respondents reported that they do not know where their district gets funding for technology, while 7.0% indicated that their district was not getting any funding. The data shows that nine main funding sources were reported by 48.8% of the respondents as shown in Figure 37 below.

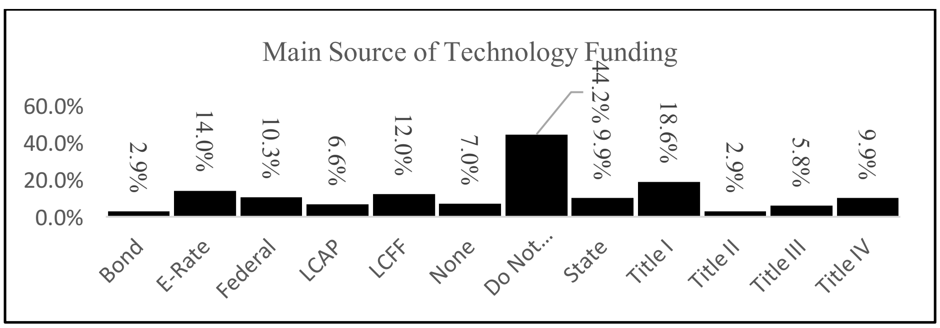

Figure 37. $N = 242$, District's main source of funding for technology.

Question: Does your district have reliable access to the Internet? The data for this question is presented in Figure 38. The data shows that 90.9% of the respondents reported that their districts have reliable access to the Internet, while 9.1% reported that their access to the Internet is either intermittent or unreliable.

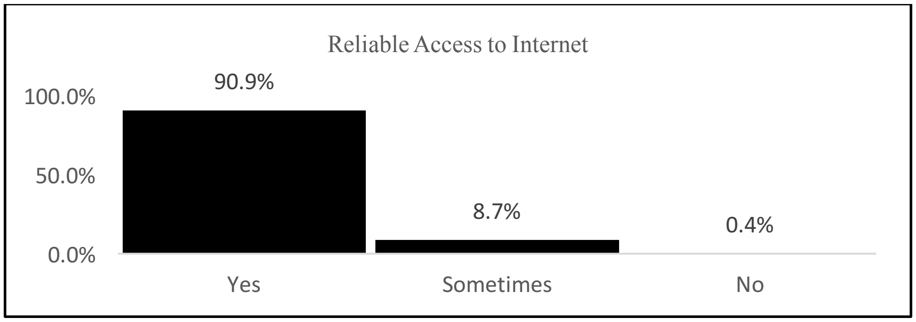

Figure 38. N = 242, Reliable access to Internet.

This part of the findings section covered all the survey questions and the following section will use the results to answer the 3 research questions that guided this study.

Findings (Part II) Answering of Research Questions

The 3 research questions:

1. How aware is the district technology leadership with the trends in current technology?
2. How aware is the district technology leaders of the intermediation between technology, pedagogy and curriculum?
3. What constraints, supports, problems, or issues related to policy and practice does the district technology leaders perceive that will affect district's ability to plan, budget and adopt technology?

Awareness of current technology trends: The analysis of the survey data that were presented in Tables A9 to A40 of this chapter provides many insights that guide the discussion for answering research question 1. Research question 1 asked about the awareness of district technology leadership with the trends in current technology. This study's survey questions that were focused around topics (a) familiarity with new technology, (b) technology knowledge acquisition, and (c) familiarity with common technology strategies were analyzed in part one of the findings section of this chapter. Analysis of the survey data shown in Tables A39 and A40 suggests that on average over 20% of the respondents reported to having no awareness of the technologies that were surveyed about, while only 17.9% indicated to having sufficient knowledge of those technologies, which leaves about 60% of the respondents somewhere in between. This study also explored how district Administrators acquire their technology knowledge. The data in Figures 33 to 35 shows that only 12.1% of the respondents reported membership to a technology focused professional organization. In addition, 21.7% of the Administrators reported participation in technology conference such as ones that are sponsored by CUE, ISTE, and Google. Participants reported that 68.8% of them did not receive any type of technology training from their district. Administrators were also asked to report about their familiarity with common technology strategies as shown in Tables A41 and A42; it was reported that over 52% of the respondents having insufficient knowledge of the strategies that was surveyed about, while less than 1/3 reported to having sufficient knowledge of those strategies.

The results of this study show that a significant percentage of school district Administrators are not equipped with the minimum knowledge necessary to implement their district's technology plan effectively. According to Enyedy (2014), and the ISTE 2016 standards there is a huge push for technology implementation in education; the Institute for Future (2011) recommends that school districts needs be aware of the current technologies and also pay close attention to major technology drivers that are transforming many aspects of the society. For instance, in this study majority of the respondents lacked sufficient awareness of the applications for artificial intelligence, while this technology along with machine learning is behind many leading smart software systems that are in use today in many modern classrooms (Wenger, 2014). Using another example, it was also evident from the data that a significant percentage of Administrators lacked sufficient awareness of the technology that relates to augmented reality, as this technology affords to much potential for increasing student engagement, improve teaching and learning outcomes (Bower et al., 2014). District Administrators lack knowledge of any important technology, such as virtual reality can deprive a district of capitalizing on the excitement that many new technologies afford within different curricular areas. New technologies often can promote greater interest in different subject areas as they seamlessly integrate with pedagogy and curriculum that for instance promote inquiry (Song, 2014). Although, more than half of the Administrators reported to having familiarity with cloud computing, however, nearly 40% of them also reported to not having sufficient familiarity with this technology. According to research lack of familiarity with cloud computing can greatly hinder a school district's ability to efficiently share and to deploy computing and academic resources (Mell & Grance, 2011). Additionally, cloud computing continues to improve, and the adoption rate for this technology is on an upward trajectory by learning institutions across the country (Johnson, Adams Becker, Cummins, & Estrada, 2012).

The data in this study show that less than 1/3 of the respondents reported having familiarity with coding and robotics technologies; research suggests that robotics and complex systems are appearing more often in many modern curricular standards where students get opportunities to use coding or logical instructions for many academic applications (Kalelioğlu, 2015). Nearly 82% of the Administrators reported to having minimal to no knowledge of computational thinking, according to research computational thinking can be considered a new type of literacy that is a necessity for modern society (Wing, 2008). Crowdsourcing is another technology strategy that was asked about, nearly 76% of the respondents reported to not having working knowledge of this strategy. Research suggests that as the need for collaborators and knowledge bases across the globe continues to grow, crowdsourcing to solve complex issues or problems is a very important consideration (Porcello & His, 2013). The data also suggest that over 70% of the Administrators surveyed reported insufficient knowledge of such things as digital badges, which is also known as microcredits. Using microcredits is a digital strategy that is vital for improving student engagement with many online curricular and pedagogical activities through validation of their accomplishments (Gibson et al., 2015). Nearly half of the Administrators reported familiarity with the concept of flipped classrooms; it is widely known in many academic circles that with the updated content standards and emerging topics in education, many districts are working hard to find ways for alternative programs to compete or survive; flipped classroom is a must strategy for districts to explore (Lo & Hew, 2017).

Today, there are many software programs and strategies that allow for visualization of information (Steichen, Carenini, & Conati, 2013). Data from this study shows that majority of Administrators reported to not having enough familiarity with visualization technologies like virtual laboratories, information visualization tools, virtual reality, visual data analysis and holographic displays. The data also revealed that when respondents were asked about technologies that related to the Internet of Things, nearly 70% reported not to be familiar with technologies that relate to the Internet of Things. As students' need grow for digital means such as mobile computing devices, interactive appliance with embedded electronics and software that sends and receives data, there is a growing focus on technologies that are associated with the Internet of Things; these technologies continue to evolve and will become a necessity in every modern classroom (Castells, 2011).

When Administrators were asked about technologies that related to learning analytics, 31% reported not to know anything about learning analytics systems, while 44.6% reported having little to some knowledge, which only leaves less than 25% that reported to be well aware of this technology. According to research, learning analytics is a critical component of the teaching and learning processes (Gašević et al., 2015). In recent years there has been an increase in the velocity of adoption of online instruction by school districts across the country; online lesson delivery also requires implementation of learning analytics tools that are usually embedded within the various Learning Management Software (Christensen & Horn, 2008). When respondents were asked about their knowledge of software that is known as Learning Management Software (LMS), over 53% reported to not know what it was, which suggest that majority of school districts do not have in place individuals that can effectively lead their online, flipped classroom and blended learning initiatives that are so vital for the 21st-century learners.

District Administrators also need to be very well informed about many adaptive learning systems and smart tutors that are benefiting from machine learning that allows for continuous optimization of the system algorithms for performance improvement to better individualize instruction. Data from this study shows that 46.3% of the respondents reported to not knowing anything about machine learning, and only 3.7% reported to having good working knowledge of the technology.

It is widely known that students like to use mobile devices, and as such, these devices are becoming a necessity and must be factored into the modern practices of everyday classrooms (Castells, 2011). Nearly 66% of the respondents from this study reported to having sufficient familiarity with mobile or handheld computing devices. Lenhart (2015) cited a survey by Pew Research Center that more than 90% of teens that use the Internet do so with some type handheld computing device like their smart phone.

As districts continue to improve their network infrastructure due to continued growth in demand for online learning, it is very important that district Administrators lead the charge to expand their district’s offerings to meet the need. As the data from this study suggests, nearly 90% of the Administrators reported to having knowledge of online learning; however, this study also asked about many applications of online learning and digital strategies that most Administrators did not know much about, which would negatively impact district's ability to take full advantage of online learning opportunities including mitigation of student dropouts and support for credit recovery efforts that many students that are at risk of not graduating require (Ferdig, 2010b).

The data also shows that over 80% of school district Administrators reported to not knowing about open source hardware that provides an important opportunity for many districts that are trying to implement programs such as the maker movement, robotics programs, or coding initiatives. District technology leaders play an important role in sparking interest within their circles of influence or around those that they supervise; suggesting that their lack of knowledge of an important technology strategy, such as the one mentioned, can significantly deprive teachers and students of opportunities; for instance, using open hardware can provide for experimental development and tweaks of existing software and hardware to extend capabilities for new applications.

Humanity is on the brink of major technological breakthroughs and the emerging technologies that this study asked about is only small scratching on the surface. One such technology that billions of people around the globe are now using social media, which can provide students with opportunities to connect with people across the globe for collaboration and participation in virtual communities. The data from this study shows that 87% of the Administrators reported having good working knowledge of social networks, however, the data also shows in Table A41 that only 40.9 % of the Administrators reported to having working knowledge of digital citizenship, which is a concept that educators must know about to keep social media participation of students safe and meaningful; suggesting that even though most

Administrators know about social media, they mostly lack the knowledge of how to manage student's activities online. Another very important strategy for online participation is content curation; Administrators reported to having only 12.6% working knowledge of curation, which according to the ISTE 2016 standards is a vital component of online participation that allows for students to meaningfully assemble, manage, and present digital content online.

Data also revealed that many district Administrators lack sufficient knowledge of virtual laboratories that are facilitated by advanced software, which the knowledge can extend student's ability to participate in many experiential learning opportunities through simulations that uses technologies that are already used with virtual reality and augmented reality simulations. For instance, virtual laboratories allow for students to uncover results by running simulations with the assistance of algorithms that uses large sets of data to model visualizations that only virtual laboratory software can make possible; these types of experiences and skills are important for students in preparation for advanced skills that jobs of the future will require. Another technology that offers countless curricular opportunities is technology systems that make visual data analysis possible. According to this research, over 75% of the Administrators reported to not having much knowledge of this technology. Wearable technology is another technology that was asked about in this study, and over 78% of the respondents reported to not having sufficient knowledge of this technology. Research suggests that wearable devices offer a vast array of sophisticated onboard analytics and interfaces that allow for a wide range of opportunities and applications in education.

The debate about the use of technology in school districts continues; the findings from this study pertaining to research question 1 has clearly demonstrated that there is a wide range of discrepancies and concerns about Administrators' awareness of some of the most popular and very important technologies that have been shown in research to have meaningful potential for today's digital age learners. District technology leaders are clearly charged with a very important task, which is to create a policy for their district's technology plan and to chart the course for a successful implementation while dealing with an evolving sea of challenges. It was also revealed from this study's data that majority of district Administrators do not have access to needed technology training, nor very many of them get the opportunity to attend technology focused conferences or belong to education technology organizations. Lack of adequate training or exposure to most vital technologies that are identified by research will severely impede transformation and amplification of learning opportunities that technology can make possible. Although it was beyond the scope of this study, it would be interesting to explore in future studies the relationship or correlation between professional conference attendance and organization membership to school Administrators technology knowledge.

The interplay of technology with pedagogy and curriculum: A series of survey questions that were organized around the TPACK framework's components, (TK) technology knowledge, (TPK) technological pedagogical knowledge and (TCK) technological content knowledge were used to address research question 2 for this study. The analysis of the survey data from Tables A43 to A48 has provided many insights about district leaderships' awareness of the intermediation between technology, pedagogy and curriculum. Based on the analysis that was presented in Chapter 2 and was grounded in latest academic literature, research suggests that understanding a technology implementation framework like the TPACK, can greatly help districts understand the importance of technology intermediation between pedagogy and content (Herring et al., 2014). Awareness of this framework allows school Administrators to work more effectively with teachers and to provide leadership in guiding the conversations and activities around the interplay of pedagogy, content, and technology through their district's technology policy and practice; this awareness can promote appropriate integration of technology into the practice of teaching (Mishra & Koehler, 2006). Furthermore, awareness of such framework by district Administrators can help center a district's technology plan around good teaching, where the focus shifts from just how to use technology alone to how the interplay or the overlap between technology, pedagogy, and curricular knowledge is appropriately accounted for within the context of academic practice.

The results of the analysis from the data in Tables A43 to A49 has provided many insights about how Administrators responded to the questions that related to the TPACK framework components: (TK) technology knowledge, (TPK) technological pedagogical knowledge, and (TCK) technological content knowledge. The results from the nine survey questions that were focused around technology knowledge are shown in Table A43, which shows that 89.5% of the respondents self-reported to having sufficient technological knowledge. What is interesting here is that research question 1 revealed that most Administrators did not report having sufficient knowledge of what is trending in education technology today; this insight suggests that most Administrators' report of their (TK) technology knowledge is based mostly on old technology.

The results from the ten survey questions that were focused around (TPK) technological pedagogical knowledge are shown in Table A44, which shows that 86.6% of respondent self-reported to having sufficient TPK. According to the data in Table A5, Administrators' average experience in education is 21.7 years, and it is possible that this factor has played a significant role in how Administrators have answered the TPACK related questions even though they mostly lack knowledge of the current technologies. It is possible that the majority of the respondents had imagined using some outdated or obsolete technology to solve many of today's pedagogical problems, however, using this strategy will is not efficient or will go far enough according to a large body of research that was discussed in chapter 2.

The results from the ten survey questions that were focused around (TCK) technological content knowledge are shown in Table A45, which shows that 81.8% of the respondents self-reported to having sufficient knowledge of technology use with curricular applications. What is interesting here is that the questions did not specify a particular technology for use with the curricular applications that were asked about; therefore, as was discussed earlier any previous experience with technology could have influenced the results. For instance, one of the questions that the survey asked about was familiarity with technology to: "collect, analyses and interpret data to make informed decisions", and 96.5% of the Administrators responded 'yes' to the question, however, the data in Table A46 shows that when Administrators were asked about their knowledge of "data analytics, information visualization, visual data analysis, and computational thinking," more than half of them indicated that they were not familiar with those particular technologies or strategies that were asked about. This suggest that Administrators might have considered only basic applications of technology with modern curricular applications.

In addition, Administrators were also asked to answer questions about their familiarity with specific state standards such as Common Core and NGSS; the results are shown in Table A47, which shows that 87.7% of the respondents self-reported to having sufficient knowledge of the standards that were asked about. In addition, the data in Table A48 shows that 82.2% of the respondents reported to having received some training related to Common Core and NGSS academic standards. Since administrators do not generally engage with students directly in the classroom, a general overview of the academic standards would be a good starting point towards better technology integration.

Here is where things get interesting; when Administrators were asked to provide information about their knowledge or exposure of any framework that related to technology implementation, the responses as shown in Table A49 reveals that only 3% reported to having had training specifically for the TPACK framework, and an additional 7% reported to having had training in the SAMR model, which is different from TPACK as the SMAR model calls for moving through degrees of technology adoption (substitution, augmentation, modification, and redefinition) instead of focusing on the intermediation of technology with pedagogy and curriculum like the TPACK framework.

The data suggests that districts are not fully aware of how to effectively integrate new technology tools within their curricular and pedagogical practice. This also suggests that many districts may be providing technology for the sake of just providing technology to their teachers without really understanding the impact or pedagogical possibilities that the new technology can have towards teaching or learning. This data also implies that district technology leaders may just approve or disapprove requests for technology tools from teachers without fully understanding the implication of their decision as the data indicate so few have little to no TPACK or SAMR framework knowledge to draw upon.

Challenges with policy and practice: The analysis of the survey data that was presented in first part of this chapter from Tables A49 to A57 has provided many insights that guides the discussion for answering research question 3. Research question 3 asked about what constraints, supports, problems, or issues related to policy and practice a district technology leader perceive to effect their district's ability to plan, budget and adopt technology. Respondents listed a wide range of constraints and policies that impede their ability to either implement technology or increase utilization; the common theme from the responses were budging, district's technology policy, technology training, and inefficiencies with the district technology infrastructure.

Since the Internet is a preferred method for communication and access to information according to (Project Tomorrow, 2011), district Administrators must look at ways to overcome issues related to access to the Internet and improve bandwidth to accommodate for things such as BYOD, VR and LMS implementation. Data suggest that majority of the districts have reliable access to the Internet; however, 71.6% of the respondents, according to the data in Table A55, were not able to provide basic information about their district's network bandwidth capabilities, suggesting that most of the Administrators that are in charge lack basic technical expertise to a most basic network related question.

According to the analysis of the data that is shown in Table A49, funding, infrastructure and training were listed as constraints that limit technology implementation. Research suggests that district leaders must provide leadership to overcome challenges that prevent adequate funding for a robust technology infrastructure, otherwise students will be deprived of opportunities for e-learning and access to other emerging technologies (Hillard and Jackson, 2011, p4). Districts are usually poorly funded, the data in Table A51 shows that the largest issue with funding is other competing priorities that often causes the cuts for technology spending. It is important for districts to spend money on appropriate technologies that are useful, for instance, they cannot just saturate their district with cheap or useless equipment and expect that teaching and learning improves (Miranda & Russell, 2012); therefore, district leaders must find ways to appropriately budget, purposefully apply technology and overcome internal or external challenges. For instance, one of the biggest challenge to technology implementation is training, which is often the first thing that impede technology integration and better student outcomes (Hofer & Swan, 2008).

Data shows that majority of district Administrators did not know what their district's spending on technology; only 21.7% of the respondents were able to provide a combined average estimate of approximately spending 289.00/student. Technology implementation is very expensive; cost associated with the network infrastructure, devices and training can be very costly; an approximate spending of at least 10% of a district's general funds is a good starting point for technology spending. Data in Tables A49 and A50 has captured responses regarding support and policy; 1 out of 4 Administrators reported that IT is supportive of technology implementation; however, 3 out of 4 don't list IT as the main support, suggesting that many districts IT department are just about connectivity and not so much about getting involved into the day to day operations of teaching and learning.

This study also asked Administrators to provide insights about problems related to policy that exist within their district, which create constraints for technology implementation. Data in Table A50 shows that 45.4% of Administrators did not see any type issues. However 54.6% listed policies that related to such things as budget, hardware, IT, training, network, parents, students, district, time, and firewall as problems or constraints that impede technology implementation.

Administrators were asked to provide information about their district technology plan; Table A56 shows that 80% of the districts that participated in the survey reported that their districts have a technology plan; however, the data in Table A57 shows that 81.0% of the respondents mentioned that their districts did not internally develop their technology plan. This suggests that many districts do not take the time to organically develop their own technology plan. Hiring consultants or simply buying a technology plan will greatly impede technology implementation.

Finally, the constraints, supports, problems, or issue that relate to policy and practice that district technology leaders perceive, which affects district's ability to plan, budget and adoption of technology ultimately dependents on the each district's ability to develop a robust technology plan that can be funded and executed by competent staff that know how to maximize the role of technology to improve student outcomes, teaching practice, and to increase the overall output of technology support for all stakeholders. The data from this study clearly indicated that most districts do not have a viable technology plan, as most buy their technology plans from either vendors or consultants; majority of the Administrators go about their business without having knowledge of their district's technology budget or infrastructure more like blind leading the blind.

Chapter 5: Conclusions and Suggestions for Future Research and Action

This chapter provides key findings and implications from this study that explored the extent to which school districts' leadership is aware of relevant 21st-century education technologies, and what district leaders know about technology interplay with curricular and pedagogical practices. Moreover, this study probed to gain insights as to what challenges district Administrators perceive in practice that relate to constraints, supports, and problems, which is often rooted in district technology policy and poses considerable challenges for planning, budgeting and adoption of technology. This chapter is organized around the three research questions, which guided this study and describes the key findings of technology awareness, technology implementation through the lens of TPACK framework, and the obstacles or constraints that impede technology implementation from policy to practice. This chapter also identifies key implications from the findings in the areas of technology awareness, knowledge acquisition for technology preparedness, district technology plan, and minimum technology readiness for K12 district Administrators. The chapter will conclude with study limitations, recommendation for future research and final thoughts.

Key Findings

K12 school districts' technology awareness: In this study, district Administrators were asked about 36 technologies and digital strategies that are widely discussed in the latest education technology research. This study found that a large number of school district Administrators are not adequately equipped to lead their district's charge to implement technology effectively. The results of this study revealed that between 20.1% to 68.1% of those Administrators that were surveyed reported to not knowing much about those technologies that were asked about, and between 14.2% to 32.1% of the Administrators reported having knowledge from moderate to high of the technologies that were asked about. Furthermore, this study found that nearly 35% of the Administrators reported to having little to no knowledge of technology strategies such as digital citizenship, content curation, blended learning and global citizenship, while between 28.5 – 46.7% reported mostly moderate level of knowledge of the digital strategies that was asked about.

As K12 educational institutions across the country are looking to improve their technology capabilities for the digital content and modern curricular requirements, district technology leaders must be proficient with their education technology knowledge that is needed for the modern practice of education, and they must also have the technical ability to understand their district's network infrastructure so they can assist with expansion capabilities that can meet the requirements for greater network bandwidth and reliability to meet the need of a modern 21st-century school district. Based on a large body of research, today technology-based services, resources and products are on an increasing trajectory, which promises to improve efficiency and outcome for both teaching and learning. Therefore, unprepared district Administrators will greatly jeopardize their district's ability to fully realize the potential of what many of the latest technologies can do for their district. Districts need to also realize that teachers' failure to make best use (or much use) of technology is most likely due to mostly incompetent Administrators that lack sufficient knowledge of today's technological tools for today's modern pedagogical and curricular practices.

With regards to technology knowledge acquisition, the data from this study shows that about 1 out of 3 Administrators reported to not having attended any type of professional conferences within the last 12 months. It was also learned that the majority of the remaining 2 out of 3 of those that had attended some type of a conference did not attend one with primary focus on technology. Furthermore, about 3 out of 4 Administrators reported to having not received any type of in-service from their district related to technology within the last 12 months. What is also interesting is that nearly 90% of the districts did not sign-up for professional memberships to organizations such as ISTE or CUE through their Administrators. It is apparent that not only most of the districts' Administrators lack sufficient knowledge of the most fundamentally important technologies for the today's students; they also have limited access to training and collaboration opportunities through conferences and professional organizations.

Implementation of technology using a framework: The study examined familiarity of Administrators with the interplay between technology, pedagogy, and curriculum through the lens of the TPACK framework. The data shows that the majority of the Administrators lack the fundamental understanding of most of the modern technologies that was asked about and the potential interplay of those technologies with modern pedagogy and curriculum. To make the connection between what Administrators reported about their familiarity with the different technologies that were asked about and their knowledge of the TPACK components: TK, TPK, and TCK, the analysis from this study shows that there appears a clear disconnect between what Administrators reported about their knowledge of new trending technologies and the applications of the TK, TPK, and TCK, suggesting that most district Administrators are going about their business of implementing and planning for technology using largely obsolete or out of date technology strategies that may not be very useful for today's pedagogical and curricular requirements. The data also suggests that most school districts are largely unaware of the need for a technology framework, such as the TPACK, as only 3% of the district Administrators reported to having knowledge of the TPCK framework; that is an indication that there isn't a systematic consideration by most school districts to use technology correctly with curriculum and pedagogy. Affirming that most school districts are implementing technology blindly without using a framework such as the TPACK and with the focus only on the 'how to' use a particular technology tool, and with not much active attention to the intermediation of technological tools between curriculum and pedagogy.

Obstacles that impede technology implementation: District Administrators reported lack of funding, training, infrastructure, and many other inadequacies with district policy as the main constraint that impedes implementation of technology. Data also suggests that over 80% of districts have a technology plan that they did not write themselves. In addition, it was revealed that most Administrators had little to no understanding of how their districts access to funding for technology or what their districts spend on technology. Surprisingly enough, majority those that were surveyed also did not know much about their district's basic network infrastructure and lacked basic technical skills to look up their district's network bandwidth capability when asked about the Internet speed and Network transport bandwidth speed. It appears from the data that Administrators are dealing with major obstacles that can only be resolved with a fundamental shift in how districts conduct their hiring to bring in more capable Administrators in the first place and then by providing professional training opportunities to continually improve district's overall knowledge of technology tools for modern pedagogical applications. Districts can also benefit by liquidating positions of Administrators that are merely going through motions and are causing regression to both teaching and learning on a daily basis.

Implications to practice

K12 school districts' technology awareness: As districts are trying to find more ways to use technology for amplification and transformation of teaching and learning, district's awareness of modern education technologies and trends with emerging technologies is the foundation on which districts can build their technology implementation plan upon. District Administrators cannot just acquire random technologies for their districts that they don't know much about and throw them at the teachers without considering implications on the teaching practice and to the student outcome. Research suggests that technology offers an enormous potential to mend gaps in equity, as well as to improve student engagement with greater individualization of instruction that promises to prepare students for careers of the future that we can mostly speculate about. Research also suggests that technology will help empower students and will give them greater ownership of their learning (Conley, 2014; Drexler, 2010; Enyedy, 2014; Ferguson, Rowley & Friedlander, 2015; Gerstein, 2016; McCombs, 2012).

It is not just about more devices; for instance, to mention just one of the strategies that was discussed in this study 'computational thinking' allows for students to use coding and logical reasoning to tackle using problem decomposition, recognition of patterns, automation with algorithms, large data handling, and many other uses that is very important digital age students (Bers, 2010; Lye, Koh, 2014; Twining, Raffaghelli, Albion & Knezek, 2013; Wing, 2008). Therefore, district technology leaders' insufficient knowledge of just one strategy, such as computational thinking, can have far-reaching negative implications for their district's academic program. This study showed that most Administrators lack basic technology competency and there is an urgent need for districts to take note and make sure that each one of their Administrators have sufficient proficiency with technology awareness as technology continues to quickly evolve, shift meaning and purpose in the context of modern teaching and learning. Districts need to develop a systematic process to ensures that only competent Administrators are in charge of their district's technology plan and that their implementation of technology readiness starts from the Superintendent on down to every site Administrator including any technology support staff. The data in study clearly showed that most Superintendents and other high level district directors are not capable of handing their district business with regards to technology.

Knowledge acquisition for technology preparedness: It is important that district training for administrators be robust, relevant and ongoing. Each school district depending on its size and setting should require that their Administrators be assessed on annual basis using a recognized technology competency metrics or standard that is grounded on research and is further guided by the latest iteration of the ISTE standards. Annual certification of district Administrators for technology readiness is another critical consideration, as technological changes are rapid and districts cannot simply get by using old or obsolete information about technology or simply get by with little knowledge of technology.

In addition, districts should consider a multifaceted approach for acquisition of knowledge for their staff and Administrators. Districts should make it mandatory that membership to key technology organizations and conferences is written in every Administrator's job description and be funded by the district. District leaders should also be held accountable and be able to demonstrate and share their knowledge formally with colleagues and other stakeholders within their district. In-house training should be done by education technology experts that understand a framework such as the TPACK for technology implementation. Districts should encourage their Administrators to collaborate with other neighboring districts and across the country to build on their success and to share information with each other.

District technology plan: This study found that majority of districts do not internally develop their technology plans and as such they either go about blindly or randomly implementing technology. It is vital for districts to develop their own technology plan organically and with intimate involvement of all their district stakeholders. The technology plan must provide for a robust network infrastructure that can support digital learning, cloud computing, and other district technology initiatives that require a fast and efficient network operations that is secure and reliable. Another important consideration for the technology plan is funding; district should quantify how much per student they can spend on technology and make efforts to prioritize funding so that the investment in technology infrastructure, training, and implementation is not impacted. This study shows that majority of the districts that were surveyed are randomly going about implementing technology with their largely ill-equipped staff of Administrators that lack significant knowledge and training.

A district technology plan should clearly specify that Administrators in charge of its Network Operation must be credentialed and have a University degree equivalent to one that emphasizes Information Systems or Network Engineering to be able to effectively orient the use of their district's technology infrastructure for the sole purpose of optimization of teaching and learning with technology. Districts needs to be selective as to who they hire and may consider services of professional recruiting companies and improve compensation to attract qualified talent to their district. District Administrators need to be involved in the teaching practice and must understand first hand how technology is used with curriculum and pedagogy. In addition, districts should provision monitoring of its technology programs and be able to make quick changes and continually adapt for more optimized outcomes. Districts should consider adding provisions in their technology plan that require minimum education technology competency requirements for all district Administrators and teachers; the metrics for minimum competency and annual testing and certification protocols should be developed using current research and recommendations from the latest iteration of the ISTE standards. Districts should collaborate with other successful districts to build on their success and have on going membership participation in technology conferences and with education technology professional organizations; in addition, it is important that districts do not write a long-term technology plan for sake of compliance or getting a plan out of the way, an ideal technology plan should only be written for one year and visited for updates periodically using implementation monitoring data from predefined monitoring or reporting periods and consider changes and contentiously evolve the plan. Lastly, it is not in the best interest of a school district to simply purchase a technology plan from some vendor or a consultant to just get by; the writing process of a technology plan by all the stakeholders is vital to its implementation, as the process will involve time and many stakeholders' input that is important for the process of the 'buy-in' to get the best results.

Minimum technology readiness: The job of a district Administrator is far more complex due to the infusion of so many technologies and new modern state of academic standards like the NGSS and the Common Core that are used today. Those Administrators that are in charge of their district's physical technology infrastructure planning and implementation such as a Chief Technology Officer should have additional technology qualifications that includes: (a) expert familiarity with current technology trends and upcoming education technologies, (b) through understanding of the teaching practice with firm grasp of the interplay between technology, pedagogy and curriculum and (c) professional level information technology background with appropriate industry standard certifications in such areas as Wi-Fi, Networking, Database, Amazon Web Services and Virtual Machine technologies and software that are common today. Other district Administrators that are involved with planning and implementation of technology should be at least familiar with items one and two that are listed above. In addition, due to increasing involvement of technology in education, school districts should be cautioned to only hire qualified and tested individuals to administer their technology planning and implementation, otherwise severe regression in teaching practice and learning outcomes will take place. District Administrators need to also have ongoing opportunities for collaboration with other districts and professional organizations to learn more about best practices and the latest trends in network and education technologies. Districts cannot develop their technology plans in isolation as complex issues will often arise and can only be solved through collaboration with others outside of the district.

Limitations and recommendation for future research

1. The underlying assumption in this study was that all school Administrators play a vital role in the development of the technology plan and are involved with the step by step implementation; therefore, success as a district Administrator in this digital age depends mostly on their awareness and use of technology. It is recommended that a future study be expanded to examine technology awareness under specific job titles such as the Superintendent, Chief Technology Officer, Technology Coach, Site Administrator, and other technology support providers; the result of the study should provide for greater insight and specificity of gaps with technology awareness.
2. The current study probed for the TPACK framework readiness using general technology questions. This limits the findings as respondents may use some old or obsolete technology tool to answer the question that were meant for modern pedagogical applications. It is suggested that future research use specific and modern technology applications such as those that are available today like Augmented Reality, Virtual Reality, Visual Data Analysis to gauge respondents' knowledge of the interplay between the three components of the TPACK framework TK, TPK, and TCK. The data from the

study will provide additional insight to guide future research and professional development for district Administrators.

3. This study was further limited by using a survey to collect data; future study should consider interviews as another method of collecting data to better understand the lived experience of district Administrators as they cope with technology. Also, survey results are self-reported and there is no way for the researcher to factor in other pertinent information to get a more precise measures of what is being studied. Researchers should take a closer look at the job descriptions of Administrators and compare their involvement with technology to their actual responsibilities as an Administrator.
4. This study reached out to all district Administrators, as such the survey questions were designed to be not too technical; future researchers should look at a set of questionnaire to gauge for technological awareness of IT directors and Chief Technology officers; as it is customary that districts hire either a Classified (without teaching credential) and a Certificated (with teaching credential) personnel for these roles. The study will provide insight as to whether a district should hire a network engineer as their IT director or a CTO with a teaching credential.
5. This study reached out to all districts across California, as such the survey results reflect a combination of elementary, middle school high school. Future research should target each district classification by itself to obtain insights that are specific to each classification. Application of technology across different district classifications vary and as such the new study can gain useful insights to guide future research as well as professional development and the development of job descriptions to fit specific responsibilities.

6. The sampling for this study was smaller than expected, which could have been due to the quality of the email addresses that were provided and to the timing of when the emails were sent out. Perhaps, if the survey were administrated during the middle of the Spring or Fall Semester it would have produced a higher response rate; also, if the email addresses are verified with each district that would increase the quality of the emails and the response rate.
7. This research used Administrators' self-reported data to make inferences about their awareness of technology; perhaps future researchers may consider asking subordinates about their boss's awareness of technology through the impact that they are making on their work. It is also recommended that a qualitative approach to data collection is used, where the researcher can study a school district's technology plan and ask pertinent questions to learn more about how district Administrators are going about their daily business of technology implementation. The insights gained will help guide the development of school districts' technology plans and also would provide useful insights as to how the roles and the responsibilities of each administrator translate from policy to practice.

Final thoughts

The outcome of this research suggests that there are many implications for district technology leaders consider the findings of this study. Implications from the findings clearly point to practice, policy and future research as described in the prior section. Districts must improve their practice with regards to gaining awareness of the emerging technologies and the practice of how they go about implementation. Training district administrators will help improve teaching and learning for the digital age students will close the digital divide. The data from this study can be generalized over districts across the country and the results point to profound lack of technology awareness by districts that require urgent attention and remediation.

A large body of research suggests that districts are faced with an increasing complexity of tasks and challenges that technology is imposing on their curricular and pedagogical practice on a continual basis. Today, it may not be enough for district Administrators to just get by with insufficient awareness of important technologies or digital strategies that are trending and are proven to be useful for educating the digital age students. The plan that a school district develops for their technology implementation hinges mostly on the district's understanding of latest research on how technology is implemented and how they can overcome challenges with regards to funding, training, and infrastructure through policy and effective implementation. Many drivers that continue to increase districts' exposure to technology impinges on other competing priorities that districts face, and only through sound planning and practice districts can successfully keep up and benefit from the affordance of technology implementation. This study provided insights into how prepared districts are and what are some with district Administrators' awareness of vital technologies that are needed for the 21st-century education. Districts that prioritize implementation and acquisition of technology with a proper understanding of the intermediation between (technology, pedagogy, curriculum) according to research will have a more effective technology implementation. Districts need to examine the role of their Administrators to make sure those that are in charge of technology planning and implementation meet a minimum requirement for technology preparedness. As the ways in which students and teachers interact with technology continues to evolve, many of the technologies that this study focused upon has already reached a tipping point where just piloting or niche adoption by districts is simply not enough. Confluences from the many technologies that are currently trending will continue to have a profound impact on education and will transform it as many emerging technologies will continue to take center stage as technology and the society continually advances in an exponential trajectory.

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APPENDIX A

Data Table from Chapters 3 and 4

Table A1

District Setting And Classification Distribution

Setting	Rural/Town	Suburb/City	*n*
Elementary	55 (22.7%)	50 (20.7%)	105 (43.4%)
High School	6 (2.5%)	21(8.7%)	27 (11.2%)
K-12	49 (20.2%)	61 (25.2%)	110 (45.4%)
Total	110 (45.5%)	132 (54.5%)	242(100%)

Note: N = 242

Table A2

District Administrator Position Distribution

Position	Rural Area/Town	Suburb/City	*n*
Director	31(12.8%)	12(5.0%)	43(17.8%)
Site Administrator	57 (23.6%)	97(40.1%)	154(63.6%)
Superintendent	22(9.1%)	23(9.5%)	45(18.6%)
Total	110 (45.5%)	132(54.5%)	242(100%)

Note: N = 242

Table A3

Student Demographics ESL & Title I

	n	ESL %	Title I %
Rural Area/Town	110	21.9	61.5
Suburb/City	132	29.7	56.9
Average		26.2	59.0

Note: N = 242

Table A4

Reported Years of Technology Experience

Positions	n	Average	Range Maximum	Range Minimum
Director				
Elementary	27	4.8	9	1
High School	5	3.2	10	0
K-12	11	4.1	8	1
Site Administrator				
Elementary	58	4.9	11	0
High School	17	4.3	9	1
K-12	79	4.7	10	1

(continued)

Superintendent Positions	n	Average	Range Maximum	Range Minimum
Elementary	20	5.0	11	1
High School	5	3.2	5	2
K-12	20	5.1	11	1

Note: N = 242; Average years of technology experience: 4.7

Table A5

Reported Years of Education Experience

Position	*n*	Average	Range Maximum	Range Minimum
Director				
Rural Area/Town	31	27.1	47	11
Suburb/City	12	27.9	38	16
Site Administrator				
Rural Area/Town	57	21.2	38	8
Suburb/City	97	20.9	43	4
Superintendent				
Rural Area/Town	22	17.6	39	5
Suburb/City	23	19.8	38	4

Note: N = 242; Average years of experience 21.7

Table A6

School District Size Distribution

District Classification	n	Average District Size by Student Population	Lowest	Highest
Elementary	105	8554	1100	37000
High School	27	12819	1020	80000
K-12	110	24689	1100	600000
Average	-	16329	-	-

Note: N = 242; Average District Size = 16,329; Range 1020 to 600000

Table A7

Survey Planning Organizer

Instrument Section	Corresponding instrument questions	Purpose	Literature resources
I	1 – 10 10 questions: Multiple choice and fill-in the blanks	To provide valuable insights that will allow for the study of segment participation and contextual information about the district setting.	
		awareness of current technology and emerging technologies. This section provides the insight to answer research	

(continued)

Instrument Section	Corresponding instrument questions	Purpose	Literature resources
		question I; How aware is the district technology leadership with the trends in current technology?	
III	16 – 21 6 questions: Likert-type, dichotomous yes/no and fill-in blank types of questions.	This section of the survey asks about leadership understanding of the intermediation between technology pedagogy and curriculum. This section provides the insight to answer research question II; How aware is the district technology leadership of the intermediation between technology, pedagogy and curriculum?	Creating Conditions for Teaching and Learning and Learning with Technology. Pages 36 – 53.
IV	22 – 30 9 questions: Multiple choice and fill-in blanks.	This section of the survey asks about technology leader's perceived constraints, supports for technology, problems related to technology implementation, or issues related to policy and practice that will affect district's ability to plan, budget and adopt technology. This section will provide insights to answer research question 3; What constraints, supports, problems, or issues related to policy and practice does the district technology leadership perceive that will affect district's ability to plan, budget and adopt technology?	Consideration for school district leadership planning and budgeting. Page 53 – 58.

Note: Survey consist of IV sections, 30 questions with associated sub-questions.

Table A8

3D Printing

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	1	0.4
2	Have heard of it.	45	18.6
3	Have demo'd it or seen demos of it.	144	59.5
4	Know it well enough to use without help.	32	13.2
5	Could help others understand when/why to use it.	15	6.2
6	Could teach it to others	5	2.1

Note: N = 242; *n* response(s) and *n*%.

Table A9

3D Video

Likert Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	34	14.0
2	Have heard of it.	85	35.1

(continued)

Likert Scale	Knowledge Level	*n*	*n%*
3	Have demo'd it or seen demos of it.	101	41.7
4	Know it well enough to use without help.	14	5.8
5	Could help others understand when/why to use it.	6	2.5
6	Could teach it to others	2	0.8

Note: N = 242, *n* response(s) and *n*%.

Table A10

Adaptive Learning

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	9	3.7
2	Have heard of it.	54	22.3
3	Have demo'd it or seen demos of it.	93	38.4
4	Know it well enough to use without help.	44	18.2
5	Could help others understand when/why to use it.	30	12.4
6	Could teach it to others	12	5.0

Note: N = 242, *n* response(s) and *n*%.

Table A11

Artificial Intelligence

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	5	2.1
2	Have heard of it.	122	50.4
3	Have demo'd it or seen demos of it.	91	37.6
4	Know it well enough to use without help.	15	6.2
5	Could help others understand when/why to use it.	8	3.3
6	Could teach it to others	1	0.4

Note: N = 242, *n* response(s) and *n*%.

Table A12

Augmented Reality

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	54	22.3
2	Have heard of it.	92	38.0
3	Have demo'd it or seen demos of it.	68	28.1
4	Know it well enough to use without help.	13	5.4
5	Could help others understand when/why to use it.	10	4.1
6	Could teach it to others	5	2.1

Note: N = 242, *n* response(s) and *n*%.

Table A13

Bring Your Own Device (BYOD)

(continued)

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	54	22.3
2	Have heard of it.	16	6.6
3	Have demo'd it or seen demos of it.	20	8.3
4	Know it well enough to use without help.	47	19.4
5	Could help others understand when/why to use it.	57	23.6
6	Could teach it to others	48	19.8

Note: *N* = 242, *n* response(s) and *n*%.

Table A14

Cloud Computing

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	20	8.3
2	Have heard of it.	34	14.0
3	Have demo'd it or seen demos of it.	43	17.8
4	Know it well enough to use without help.	65	26.9
5	Could help others understand when/why to use it.	43	17.8
6	Could teach it to others	37	15.3

Note: *N* = 242, *n* response(s) and *n*%.

Table A15

Coding

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	2	0.8
2	Have heard of it.	47	19.4
3	Have demo'd it or seen demos of it.	122	50.4
4	Know it well enough to use without help.	35	14.5
5	Could help others understand when/why to use it.	28	11.6
6	Could teach it to others	8	3.3

Note: *N* = 242, *n* response(s) and *n*%.

Table A16

Computational Thinking

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	72	29.8
2	Have heard of it.	84	34.7
3	Have demo'd it or seen demos of it.	42	17.4
4	Know it well enough to use without help.	26	10.7
5	Could help others understand when/why to use it.	10	4.1
6	Could teach it to others	8	3.3

Note: *N* = 242, *n* response(s) and *n*%.

Table A17

(continued)

Crowdsourcing Response

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	43	17.8
2	Have heard of it.	89	36.8
3	Have demo'd it or seen demos of it.	52	21.5
4	Know it well enough to use without help.	31	12.8
5	Could help others understand when/why to use it.	17	7.0
6	Could teach it to others	10	4.1

Note: N = 242, *n* response(s) and *n*%.

Table A18

Data Analytics

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	18	7.4
2	Have heard of it.	60	24.8
3	Have demo'd it or seen demos of it.	59	24.4
4	Know it well enough to use without help.	49	20.2
5	Could help others understand when/why to use it.	33	13.6
6	Could teach it to others	23	9.5

Note: N = 242, *n* response(s) and *n*%.

Table A19

Digital Badges

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	46	19.0
2	Have heard of it.	60	24.8
3	Have demo'd it or seen demos of it.	65	26.9
4	Know it well enough to use without help.	35	14.5
5	Could help others understand when/why to use it.	19	7.9
6	Could teach it to others	17	7.0

Note: N = 242, *n* response(s) and *n*%.

Table A20

Flipped Classrooms

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	15	6.2
2	Have heard of it.	30	12.4
3	Have demo'd it or seen demos of it.	71	29.3
4	Know it well enough to use without help.	46	19.0
5	Could help others understand when/why to use it.	46	19.0
6	Could teach it to others	34	14.0

Note: N = 242, *n* response(s) and *n*%.

Table A21

(continued)

Information Visualization

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	77	31.8
2	Have heard of it.	78	32.2
3	Have demo'd it or seen demos of it.	40	16.5
4	Know it well enough to use without help.	20	8.3
5	Could help others understand when/why to use it.	17	7.0
6	Could teach it to others	10	4.1

Note: *N* = 242, *n* response(s) and *n*%.

Table A22

Internet Of Things

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	98	40.5
2	Have heard of it.	47	19.4
3	Have demo'd it or seen demos of it.	27	11.2
4	Know it well enough to use without help.	21	8.7
5	Could help others understand when/why to use it.	31	12.8
6	Could teach it to others	18	7.4

Note: *N* = 242, *n* response(s) and *n*%.

Table A23

ISTE Standards

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	61	25.2
2	Have heard of it.	53	21.9
3	Have demo'd it or seen demos of it.	38	15.7
4	Know it well enough to use without help.	39	16.1
5	Could help others understand when/why to use it.	32	13.2
6	Could teach it to others	19	7.9

Note: *N* = 242, *n* response(s) and *n*%.

Table A24

Learning Analytics

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	75	31.0
2	Have heard of it.	64	26.4
3	Have demo'd it or seen demos of it.	44	18.2
4	Know it well enough to use without help.	31	12.8
5	Could help others understand when/why to use it.	19	7.9
6	Could teach it to others	9	3.7

Note: *N* = 242, *n* response(s) and *n*%.

Table A25

(continued)

Learning Management Software (LMS)

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	129	53.3
2	Have heard of it.	33	13.6
3	Have demo'd it or seen demos of it.	20	8.3
4	Know it well enough to use without help.	22	9.1
5	Could help others understand when/why to use it.	19	7.9
6	Could teach it to others	19	7.9

Note: N = 242, *n* response(s) and *n*%.

Table A26

Location Intelligence

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	116	47.9
2	Have heard of it.	70	28.9
3	Have demo'd it or seen demos of it.	30	12.4
4	Know it well enough to use without help.	15	6.2
5	Could help others understand when/why to use it.	6	2.5
6	Could teach it to others	5	2.1

Note: N = 242, *n* response(s) and *n*%.

Table A27

Machine Learning

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	112	46.3
2	Have heard of it.	78	32.2
3	Have demo'd it or seen demos of it.	29	12.0
4	Know it well enough to use without help.	14	5.8
5	Could help others understand when/why to use it.	8	3.3
6	Could teach it to others	1	0.4

Note: N = 242, *n* response(s) and *n*%.

Table A28

Mobile/Handheld Computing

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	9	3.7
2	Have heard of it.	33	13.6
3	Have demo'd it or seen demos of it.	39	16.1
4	Know it well enough to use without help.	59	24.4
5	Could help others understand when/why to use it.	51	21.1
6	Could teach it to others	51	21.1

Note: N = 242, *n* response(s) and *n*%

Table A29

(continued)

Online Learning Response

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	0	0.0
2	Have heard of it.	8	3.3
3	Have demo'd it or seen demos of it.	14	5.8
4	Know it well enough to use without help.	75	31.0
5	Could help others understand when/why to use it.	64	26.4
6	Could teach it to others	81	33.5

Note: $N = 242$, *n* response(s) and *n*%.

Table A30

Open Hardware

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	102	42.1
2	Have heard of it.	58	24.0
3	Have demo'd it or seen demos of it.	35	14.5
4	Know it well enough to use without help.	28	11.6
5	Could help others understand when/why to use it.	8	3.3
6	Could teach it to others	11	4.5

Note: $N = 242$, *n* response(s) and *n*%.

Table A31

Robotic Tools

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	23	9.5
2	Have heard of it.	91	37.6
3	Have demo'd it or seen demos of it.	80	33.1
4	Know it well enough to use without help.	31	12.8
5	Could help others understand when/why to use it.	14	5.8
6	Could teach it to others	3	1.2

Note: $N = 242$, *n* response(s) and *n*%.

Table A32

Social Networks

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	2	0.8
2	Have heard of it.	11	4.5
3	Have demo'd it or seen demos of it.	19	7.9
4	Know it well enough to use without help.	67	27.7
5	Could help others understand when/why to use it.	79	32.6
6	Could teach it to others	64	26.4

Note: $N = 242$, *n* response(s) and *n*%.

(continued)

Table A33

Virtual Laboratories

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	41	16.9
2	Have heard of it.	61	25.2
3	Have demo'd it or seen demos of it.	63	26.0
4	Know it well enough to use without help.	44	18.2
5	Could help others understand when/why to use it.	22	9.1
6	Could teach it to others	11	4.5

Note: N = 242, *n* response(s) and *n*%.

Table A34

Virtual Reality

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	9	3.7
2	Have heard of it.	68	28.1
3	Have demo'd it or seen demos of it.	93	38.4
4	Know it well enough to use without help.	37	15.3
5	Could help others understand when/why to use it.	23	9.5
6	Could teach it to others	12	5.0

Note: N = 242, *n* response(s) and *n*%.

Table A35

Visual Data Analysis

Likert-Scale	Knowledge Level	*n*	*n%*
1	Don't know what this is.	64	26.4
2	Have heard of it.	73	30.2
3	Have demo'd it or seen demos of it.	49	20.2
4	Know it well enough to use without help.	28	11.6
5	Could help others understand when/why to use it.	15	6.2
6	Could teach it to others	13	5.4

Note: N = 242, *n* response(s) and *n*%.

Table A36

Volumetric/Holographic Display

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	98	40.5
2	Have heard of it.	90	37.2
3	Have demo'd it or seen demos of it.	40	16.5
4	Know it well enough to use without help.	12	5.0
5	Could help others understand when/why to use it.	1	0.4
6	Could teach it to others	1	0.4

Note: N = 242, *n* response(s) and *n*%.

Table A37

Wearables

Likert-Scale	Knowledge Level	n	*n%*
1	Don't know what this is.	75	31.0
2	Have heard of it.	77	31.8
3	Have demo'd it or seen demos of it.	39	16.1
4	Know it well enough to use without help.	26	10.7
5	Could help others understand when/why to use it.	13	5.4
6	Could teach it to others	12	5.0

Note: N = 242, *n* response(s) and *n*%.

Table A38

Overall Technology Awareness Data

Knowledge Level	None			Low			Moderate			Expert	
Technology	n	%	Technology	n	%	Technology	n	%	Technology	n	%
machine learning	112	46	3D videos	186	76	cloud computing	65	26.6	(BYOD)	105	42.9
LMS	129	53	Artificial intelligence	214	87	online learning	75	30.7	online learning	147	60.2
open hardware	102	42	robotic tools	170	70	mobile computing	59	24.3	mobile computing	102	42.0
internet of things	97	40	coding	170	70	data analytics	49	20.3	cloud computing	80	32.8
volumetric display	98	40	virtual reality	159	65	flipped classroom	48	19.7	flipped classroom	80	32.8
information visualization	77	32	augmented reality	161	65	(BYOD)	47	19.2	data analytics	56	23.1
learning analytics	75	31	adaptive learning	148	61	virtual laboratories	44	18.4	ISTE standards	51	21.3
wearables	75	30	crowdsourcing	143	59	adaptive learning	44	18.1	internet of things	49	20.4
computational thinking	72	30	volumetric display	132	54	ISTE standards	39	16.3	adaptive learning	42	17.3
visual data analysis	64	26	virtual laboratories	125	52	virtual reality	39	16.1	LMS	38	15.8
ISTE standards	61	25	computational thinking	125	52	digital badges	35	14.5	digital badges	36	14.9
(BYOD)	55	22	digital badges	124	52	coding	35	14.4	coding	36	14.8
augmented reality	54	22	visual data analysis	120	50	3D Printing	32	13.1	virtual reality	36	14.8
digital badges	46	19	data analytics	119	49	robotic tools	31	12.9	virtual laboratories	32	13.4
crowdsourcing	43	17	information visualization	116	48	learning analytics	31	12.8	visual data analysis	28	11.7
virtual laboratories	38	15	wearables	117	48	crowdsourcing	31	12.7	learning analytics	28	11.6
3D videos	34	14	learning analytics	108	45	visual data analysis	28	11.7	information visualization	27	11.3
robotic tools	23	9	machine learning	107	44	open hardware	27	11.2	crowdsourcing	27	11.1
cloud computing	20	8	flipped classroom	101	41	computational thinking	26	10.8	wearables	25	10.3
data analytics	18	7	location intelligence	100	41	wearables	26	10.7	3D Printing	20	8.2
flipped classroom	15	6	open hardware	93	39	LMS	22	9.1	open hardware	19	7.9
virtual reality	9	3	ISTE standards	89	37	internet of things	21	8.8	robotic tools	17	7.1
adaptive learning	9	3	cloud computing	79	32	Information visualization	20	8.3	computational thinking	17	7.1
mobile computing	9	3	internet of things	73	30	augmented reality	16	6.5	augmented reality	15	6.1
artificial intelligence	5	2	mobile computing	73	30	location intelligence	15	6.2	artificial intelligence	11	4.5
coding	2	1	LMS	52	22	artificial intelligence	15	6.1	location intelligence	11	4.5
social networks	2	1	BYOD)	38	16	machine learning	14	5.8	machine learning	9	3.7
3D Printing	1	0	social networks	30	12	3D videos	14	5.8	3D videos	8	3.3
online learning	0	0	online learning	22	9	volumetric display	12	4.9	volumetric display	2	0.8

Table A39

Digital Strategies and Maker Movement

(continued)

Likert Scale	Technology Strategy	don't know what this is		have heard of it		have demo'd it or seen demos of it		know it well enough to use without help		could help others understand when/why to use it		could teach it to others		N
		n%	*n*	*n%*	*n*	*n%*	*n*	*%*	*n*	*n%*	*n*	*n%*	*n*	
1	digital citizenship	5.6	14	12.8	32	16.8	42	23.6	59	22.1	55	18.8	47	243
2	content curation	50.2	122	20.9	51	9.8	24	6.1	15	6.5	16	6.1	15	243
4	blended learning	3.6	9	14.2	35	21.2	52	27.3	67	16.3	40	17.1	42	245
5	maker movement	21.5	53	19.1	47	19.1	47	18.2	45	16.2	40	5.6	14	240
6	global citizenship	7.4	18	20.9	51	20.1	49	19.7	48	21.4	52	10.2	25	243
	Column Average	17.7	43	17.7	43	17.5	43	19.1	47	16.5	41	11.6	29	242

Note: N = 242, *n* response(s) and *n*%.

Table A40

Combined Digital Strategies And Maker Movement

Original Likert-Scale	Consolidated Liker-Scale	Knowledge Level	Knowledge Level	*n*	*n%*
1 2	1	Don't know what this is. Have heard of it.	None to Very Low	86	35.0
3	2	Have demo'd it or seen demos of it.	Low	43	17.5
4	3	Know it well enough to use without help.	Moderate	47	19.1
5 6	4	Could help others understand when/why to use it. Could teach it to others	High to Very High	53	28.5

Note: N = 242, *n* response(s) and *n*%.

Table A41

Technology Knowledge (TK)

		yes		*no*		N
1	create presentations with (e.g., Pratzi, Powerpoint)	99.5	230	0.4	1	231
2	create and edit simple images (e.g. Microsoft Paint or Photoshop)	94.7	217	5.2	12	229
3	make calculations on a spreadsheet (Excel, Google Sheets)	94.3	215	5.7	13	228
4	create charts/graphs using a spreadsheet (Excel, Google Sheets)	96.4	219	3.5	8	227
5	use a graphic calculator	72.7	152	27.2	57	209
6	locate and evaluate subject specific online applications and tools (e.g. learning objects, apps, simulators)	92.5	199	7.4	16	215
7	use content specific software applications (e.g., GeoGebra, Geometer's Sketchpad, Maple, Mathematica)	67.9	127	32.1	60	187
8	construct multimedia objects embedding pictures, sound and animations	89.7	193	10.2	22	215
9	network with other colleagues and professional associations through online forums, social media, etc.	96.9	221	3.1	7	228
	Average	89.5%	197	10.5	22	219

Note: N = 219; mean for (*yes)* type answer =89.5%; mean for (*no)* type answer= 10.5%

Table A42

Technological Pedagogical Skills (TPK)

	I am able to…	*yes*		*no*		*N*
		n%	*n*	*n%*	*n*	
1	use technology to develop students' research skills	97.4	224	2.6	6	230
2	teach a concept using an interactive whiteboard	79.5	175	20.4	45	220
3	create a WebQuest to deliver a curriculum unit	55.5	111	44.5	89	200
4	use mobile devices (i.g, iPad, smartphone) in teaching	94.8	217	5.2	12	229
5	engage students in collaborative learning through wikis	62.6	122	37.4	73	195
6	guide students in creating their own multimedia presentations	93.4	207	6.7	15	222
7	deal with cyberbullying and cyber-safety issues in the school	98.7	220	1.3	3	223
8	use technology to provide alternative assessments	95.5	214	4.4	10	224
9	engage students in critically analyzing online texts or images	94.1	207	5.9	13	220
10	appraise educational websites and software for usefulness and quality	94.3	200	5.6	12	212
	Average	86.6	190	13.4	28	218

Note: N = 190; mean for *(yes)* type answer = 86.6%; mean for *(no)* type answer = 13.4%

Table A43

Technological Curriculum Knowledge (TCK)

1	assist students to develop their subject specific problem-solving skills	89.2	207	4.7	11	232
2	represent subject problems linking logical, symbolic, numerical and graphical data	68.2	157	14.3	33	230
3	demonstrate subject specific models or concepts through learning objects (e.g., animations, simulations, online applications).	60.7	141	23.7	55	232
4	identify trends and patterns to predict possibilities	72.4	166	15.7	36	229
5	explore or present subject specific content in a variety of different ways	92.1	212	4.7	11	230
6	collect, analyses and interpret data to make informed judgment	96.5	221	1.7	4	229
7	incorporate authentic tasks in the learning of a specific subject matter	88.6	203	6.5	15	229
8	promote substantive student communication in a subject specific lesson (e.g., class discussion on multiple methods of solving a problem)	91.2	209	4.3	10	229
9	integrate the study of a specific subject with content from other Key Learning Areas (e.g. English, Art, Science, History)	90.9	210	5.6	13	231
10	Support students' mathematical investigation with digital tools (e.g., audio/video recording)	68.9	160	15.5	36	232
	Average	81.8	189	9.7	22	230

Note: N = 230; mean for *(yes)* type answer = 81.8%; mean for *(no)* type answer = 9.7%

Table A44

Framework Training Response Distribution

Framework	*n*	*n%*
SAMR	18	7
TPACK	7	3
None	129	53
Framework	*n*	*n%*
Unrelated Response	88	36

Note: N = 242, *n* response(s) and *n*%.

Table A45

Curriculum Standards Familiarity

Question	don't know what this is		have hared of it		have demo'd it or seen demos of		know it well enough to use without help		could help others understand when/why to use it		could teach it to others		N
	n%	*n*	*n%*	*n*	*n%*	*n*	*n%*	*n*	*n%*	*n*	*n%*	*n*	
English	0.0	0	1.3	3	3.4	8	18.0	42	27.0	63	50.2	117	233
Mathematics	0.0	0	1.7	4	3.5	8	22.9	53	31.6	73	40.3	93	231
Science	2.6	6	4.4	10	18.9	43	26.4	60	29.9	68	17.6	40	227
Average	0.9	2	2.5	6	8.6	20	22.4	52	29.5	68	36.0	83	230

Note: N = 242, *n* response(s) and *n*%.

Table A46

Consolidated Curriculum Standards Familiarity

Original Likert-Scale	Consolidated Liker-Scale	Knowledge Level	Knowledge Level	*n*	*n%*
1	1	Don't know what this is.	None to Very Low	8	3.4%
2		Have heard of it.			
3	2	Have demo'd it or seen demos of it.	Low	20	8.6%
4	3	Know it well enough to use without help.	Moderate	52	22.4%
5	4	Could help others understand when/why to use it.	High to Very High	151	65.5%
6		Could teach it to others			

Note: N = 242, *n* response(s) and *n*%.

Table A47

Curriculum Standards Training

	n	*n%*
No Training	26	11%
Training on one or more standards	199	82%

(continued)

	n	*n%*
Blank or unrelated response	17	7%
Total	242	100%

Note: N = 242, *n* response(s) and *n*%.

Table A48

Constraints That Limits Technology Implementation

	n	n%
Funding	131	54
	n	*n%*
Infrastructure	73	30
	n	n%
Training	101	42
Blank or unrelated response	22	9

Note: N = 242

Table A49

Type Of Internal Support For Technology

	n	*n%*
Technology Coaches	19	7.9%
IT	62	25.6%
Teachers	6	2.5%
Staff	41	16.9%
Don't know	31	12.8%
Parents	2	0.8%
None	21	8.7%
Volunteers	3	1.2%
Community	2	0.8%
Administrators	12	5.0%
Students	15	6.2%
Training	3	1.2%
Aides	1	0.4%
Misc.	24	9.9%

Note: N = 242, *n* response(s) and *n*%.

Table A50

Policy Problem(s) That Impedes Technology Implementation

	n	*n%*
Budget	11	4.6
Current District Policy	14	5.9
Hardware	2	0.8
IT	44	18.5

(continued)

	n	*n%*
Lack of Training	12	5.0
Network Connectivity Issues	3	1.3
None	108	45.4
Parent	6	2.5
Student	9	3.8
Teachers	6	2.5
Time	15	6.3
Unknown	4	1.7
Vetting for hardware and software	2	0.8
Website Filters	2	0.8

Note: *N* = 242, *n* response(s) and *n*%.

Table A51

Perceived Constraints

	n	*n%*
High cost for training for technology	5	2.9
Other	12	7.0
None	75	43.9
Technology Department Budget	18	10.5
LCFF (State Funding)	6	3.5
Availability of Grants	4	2.3
Other competing priorities	50	29.2
Fiscal policy and deadline constraints	1	0.6

Note: *N* = 171, *n* response(s) and *n*%.

Table A52

Policy And Practice That Impede Technology Utilization & Adoption

	n	*n%*
Vetting	2	1.0
Training	20	9.8
Teacher	28	13.7
Parents	4	2.0
None	76	37.1
LCFF	2	1.0
Lack of resources	20	9.8
Knowledge	4	2.0
Funding	14	6.8
Fiscal	2	1.0
BYOD	2	1.0
Budget	11	5.4
Ability	10	4.9

Note: *N* = 205, *n* response(s) and *n*%.

Table A53

Per Student Expenditure

Answer	*n*%	*n*
Per student expenditure (Reported)	21.6	47
don't know	78.3	170
Total	100	217

Note: *N* = 217, *n* response(s) and *n*%.

Table A54

Per Student Expenditure

Descriptive Statistics for 47 Responses (31 answers were Blank, and 170 respondents stated "I do not know".	
Mean	$289
Standard Error	$45
Median	2000
Mode	$200
Standard Deviation	$290
Sample Variance	85381
Kurtosis	7.23
Skewness	2.48
Range	$1487
Minimum	$13
Maximum	$1500
Count	47
Confidence Level(95.0%)	91.06

Note: *N* = 47, Expenditure/Student.

Table A55

Knowledge Of Internet Bandwidth

	n%	*n*
for the Internet	28.3	55
don't know the Internet bandwidth	71.7	139
for the network transport (LAN or WAN)	17.7	31
don't know the (LAN or WAN) bandwidth	82.3	144
		175
Total		

Note: *N* = 194, *n* response(s) and *n*%.

Table A56

Internet Reliability

	Yes (n)	*No (n)*	*Sometimes (n)*	*Blank (n)*	*n* =
City/Suburb	118 (48.8%)	1 (0.4%)	12 (5.0%)	2 (0.8%)	133

(continued)

	Yes (n)	*No (n)*	*Sometimes (n)*	*Blank (n)*	*n =*
Rural/Town	100 (41.3%)	0	9 (3.7%)	0	109
Total count	218 (90.1%)	(1) 0.4%	21(8.7%)	2(08%)	242

Note: N=240, *n* response(s) and *n*%.

Table A57

Knowledge of District Technology Plan

Response	*n%*	*n*
yes	80.7	176
no	11.0	24
don't know	8.3	18
Total	100.0	218

Note: N = 242, *n* response(s) and *n*%.

Table A58

Technology Plan Written By District

		n%	*n =*
1	yes	6.2	11
2	no	81.0	145
3	other	12.6	23
	Total	100	179

Note: N = 179, *n* response(s) and *n*%.

APPENDIX B

Survey Development

ONLINE INFORMED CONSENT TO PARTICIPATE IN RESEARCH
Pepperdine University School of Education and Psychology
Doctoral Program in Education Learning Technologies

IRB# ___________
Thank you in advance for completing this survey. Your participation will aid in understanding how school districts are coping with emerging technologies and the burden that technology places on their budget, planning, and vision. Please review the informed consent information below.

RESEARCHER & OBJECTIVE: Alex N. Sedique, a graduate student at Pepperdine University School of Education and Psychology, is conducting a research study on school district's awareness of technology for the purpose of planning, budgeting, planning and implementation. You, along with all school district technology leaders in California's school districts of 5000 students or greater, have been selected to participate in this State-wide study. This study has two main objectives: (1) School district technology leader's perspectives are critical to understanding how school districts develop their technology plans within various constraints. (2) Your input from this study will provide data to help guide future research on the topic of study.

STUDY TITLE: Coping with emerging technologies: Burden on School District's vision, budget, planning, and implementation.

METHODS AND PROCEDURES: INFORMATION ABOUT PARTICIPANTS' INVOLVEMENT IN THE STUDY: Participants will complete a four part survey online consisting of thirty three questions that include four sections.

Section I - (Demographics Information) - Demographics
Questions number: 1 – 10

Purpose: To provide valuable insights that will allow for the study of segment participation and contextual information about the district setting.

Multiple choice and fill-in the blanks

Section II – This section of the Survey focuses on the context in which a technology leader works with regards to their awareness of current technology and emerging technologies. Questions number: 11 – 15

Section III – This section of the survey asks about leadership understanding of the intermediation between technology pedagogy and curriculum. Questions number: 16 – 21

Section IV – This section of the survey asks about technology leader's perceived constraints, supports for technology, problems related to technology implementation, or issues related to policy and practice that will affect district's ability to plan, budget and adopt technology? Questions number: 22 – 30

RISKS: There are no known risks to participate in the survey. Specifically, minimal risk, meaning that the probability and magnitude of harm(s) or discomfort(s) anticipated in the research are not greater than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations. Completing the surveys provides the most accurate data to the researcher.

BENEFITS: This research will contribute to the body of knowledge about school district technology awareness that will inform literature and help guide future research.

CONFIDENTIALITY: Every effort to protect anonymity will be taken. Based on characteristics identified by the demographic questions, it will not be possible for the researcher to identify participants. All attempts to maintain confidentiality will be upheld by the researcher. Every precaution has been taken to ensure that your identity is protected. No reference will be made in oral or written reports which could link participants to the study. We do this to ensure that your responses remain confidential and that you feel free to respond as candidly as possible. All information in the study records will be kept confidential. Only the researcher will have access to the information you provide. Data will be stored securely and will be made available only to the researcher conducting the study. The data will be stored on a password-protected personal laptop. After three years, all data will be destroyed.

COMPENSATION: There is no compensation for participating in this study. However, a drawing will be offered to participants for a chance to win one of four $50 Amazon gift cards. At the conclusion of the survey, you will have an opportunity to complete a separate form to enter into a drawing for one of four $50 Amazon gift cards. The incentive information is not connected to this study; thus, protecting your identity. If you are a winner in the drawing, you will be notified via email by June 30, 2017.

PARTICIPATION: Your participation in this study is voluntary. You may decide not to consent to participate and decline to participate without penalty. You may decide not to answer a question or skip any question and continue to participate in the rest of the study. Once responses have been submitted and anonymously recorded participants will not be able to withdraw from the study. There are no costs to participants for participation in the research.

CONTACT INFORMATION: If I have any questions, I can contact Alex Sedique at [redacted]. If I have further questions, I may contact Dr. Polin at Linda.Poin@pepperdin.edu. If I have concerns or complaints about the conduct of this research, I can contact Dr. Judy Ho (GSEP IRB Chairperson) at judy.ho@pepperdine.edu or 310-568-5753.

CONSENT: All my questions have been answered to my satisfaction. I have received a copy of this informed consent form, which I have read and understand. I hereby consent to participate in the research described above.
By clicking "I agree" below you are indicating that you are at least 18 years old, have read and understood this consent form and agree to participate in this research study. Please print a copy of this page for your records.

- [ ] I agree to participate in this survey research

Section I - (Demographics Information) - The following items provide contextual information about you and your district setting.
10 Multiple Choice, Likert-type and text fill in the blank questions.

Which answer best describes your district setting:

- suburb
- town
- city
- rural area

Which best describes your district classification:

- elementary district
- high school district
- unified, K-12 district
- other

What is your job title in the district with regard to technology?

- director of information technology - classified
- director of information technology - certificated
- director of educational or instructional technology
- other

How many years have you worked in education? (Administration or Teaching)

Approximately how many students are enrolled in your district?

How many years have you worked in the technology field such as IT?

What is the approximate percentage of the students within your district that are classified as English Language Learners? (if none, write none).

What is the approximate percentage of the students within your district that qualify for free or reduced lunch? (if none, write none).

Which government (Federal or State) funding, if any, does your district receive to support its technology program? (if none, write none).

Does your district have reliable access to the Internet?

- yes
- no
- sometimes

Section II - This section of the Survey focuses on the context in which you work with regards awareness of current technology and emerging technologies.
6 Likert-type questions & fill-in blanks

Describe your level of awareness and understanding of these Technologies or digital strategies.

	Don't know what this is	Have heard of it	Have demo'd it or seen demos of it	Know it well enough to use without help	Could help others understand when/why to use it	Could teach it to others
3D Printing						
3D videos						
adaptive learning						
artificial intelligence						
augmented reality						
BYOD						
cloud computing						
coding						
crowdsourcing						
data analytics						
digital badges						
flipped classroom						
information visualization						
internet of things						
learning analytics						
location intelligence						
machine learning						
mobile/handheld computing						
online learning						
open hardware						
robotic tools						
social networks						
virtual laboratories						
virtual reality						
visual data analysis						
volumetric & holorgpahic display						
wearables						
ISTE standards						
LMS						
computational thinking						

Which professional organizations, if any, do you belong to? (if none, write none).

Which job related professional conference(s), if any, have you attended within the last year? (if none, write none).

Which job related professional training(s), if any, have you received in the past year? (if none, write none)?

Describe your expertise with ...

	don't know what this is	have heard of it	have demo'd it or seen demos of it	know it well enough to use without help	could help others understand when/why to use it	could teach it to others
digital citizenship	☐	☐	☐	☐	☐	☐
curation	☐	☐	☐	☐	☐	☐
blended learning	☐	☐	☐	☐	☐	☐
maker movement	☐	☐	☐	☐	☐	☐
global citizenship	☐	☐	☐	☐	☐	☐

Section III - This section of the survey asks about leadership understanding of the intermediation between technology pedagogy and curriculum. (6 Likert-type, fill-in blanks and dichotomous type questions)

I am able to use technology to ...

	yes	no	not sure
create presentations with (e.g., Pratzi, Powerpoint)	☐	☐	☐
create and edit simple images (e.g. Microsoft Paint or Photoshop)	☐	☐	☐
make calculations on a spreadsheet (Excel, Google Sheets)	☐	☐	☐
create charts/graphs using a spreadsheet (Excel, Google Sheets)	☐	☐	☐
use a graphic calculator	☐	☐	☐
locate and evaluate subject specific online applications and tools (e.g. learning objects, apps, simulators)	☐	☐	☐
use content specific software applications (e.g., GeoGebra, Geometer's Sketchpad, Maple, Mathematica)	☐	☐	☐
construct multimedia objects embedding pictures, sound and animations	☐	☐	☐
network with other colleagues and professional associations through online forums, social media, etc	☐	☐	☐

I am able to ...

	yes	no	not sure
use technology to develop students' research skills	☐	☐	☐
teach a concept using an interactive whiteboard	☐	☐	☐
create a webquest to deliver a curriculum unit	☐	☐	☐
use mobile devices (i.g, iPad, smartphone) in teaching	☐	☐	☐
engage students in collaborative learning through wikis	☐	☐	☐
guide students in creating their own multimedia presentations	☐	☐	☐
deal with cyberbullying and cybersafety issues in the school	☐	☐	☐
use technology to provide students with alternative forms of assessment	☐	☐	☐
engage students in critically analysing online texts or images	☐	☐	☐
appraise educational websites and software for usefulness and quality	☐	☐	☐

I am able to use technology to ...

	yes	no	not sure
assist students to develop their subject specific problem-solving skills	☐	☐	☐
represent subject problems linking logical, symbolic, numerical and graphical data	☐	☐	☐
demonstrate subject specific models or concepts through learning objects (e.g., animations, simulations, online applications).	☐	☐	☐
identify trends and patterns to predict possibilities	☐	☐	☐
explore or present subject specific content in a variety of different ways	☐	☐	☐
collect, analyse and interpret data to make informed judgement	☐	☐	☐
incorporate authentic tasks in the learning of a specific subject matter	☐	☐	☐
promote substantive student communication in a subject specific lesson (e.g., class discussion on multiple methods of solving a problem)	☐	☐	☐
integrate the study of a specific subject with content from other Key Learning Areas (e.g. English, Art, Science, History)	☐	☐	☐
Support students' mathematical investigation with digitial tools (e.g., audio/video recording, measuring devices, etc)	☐	☐	☐

Rate your overall level of familiarity with current curriculum standards.

	don't know what this is	have hared of it	have demo'd it or seen demos of if	know it well enough to use without help	could help others understand when/why to use it	could teach it to others
Common Core ELA	☐	☐	☐	☐	☐	☐
Common Core Math	☐	☐	☐	☐	☐	☐
NGSS	☐	☐	☐	☐	☐	☐

If you are aware of a theoretical framework for technology implementation, if any, please describe it below. (if none, write none).

For which standard (e.g., Common Core State Standards, NGSS, ISTE), if any, you received training? (if none, write none).

APPENDIX C

IRB Approval Documentation

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)
COMPLETION REPORT - PART 1 OF 2
COURSEWORK REQUIREMENTS*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Alex Sedique
- **Institution Affiliation:** Pepperdine University
- **Institution Email:**
- **Institution Unit:** N/A

- **Curriculum Group:** GSEP Education Division
- **Course Learner Group:** GSEP Education Division - Social-Behavioral-Educational (SBE)
- **Stage:** Stage 1 - Basic Course

- **Record ID:**
- **Completion Date:** 31-May-2017
- **Expiration Date:** 30-May-2022
- **Minimum Passing:** 80
- **Reported Score*:** 91

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID: 1127)	31-May-2017	3/3 (100%)
History and Ethical Principles - SBE (ID: 490)	31-May-2017	4/5 (80%)
Defining Research with Human Subjects - SBE (ID: 491)	31-May-2017	4/5 (80%)
The Federal Regulations - SBE (ID: 502)	31-May-2017	4/5 (80%)
Assessing Risk - SBE (ID: 503)	31-May-2017	5/5 (100%)
Informed Consent - SBE (ID: 504)	31-May-2017	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	31-May-2017	5/5 (100%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

Verify at: www.citiprogram.org/verify/?k72276b2f-8df1-4e9c-ae35-cdad3488c5cf-23343623

Collaborative Institutional Training Initiative (CITI Program)
Email:
Phone
Web: |

PEPPERDINE

Pepperdine University
24255 Pacific Coast Highway
Malibu, CA 90263

NOTICE OF APPROVAL FOR HUMAN RESEARCH

Date: August 09, 2017

Protocol Investigator Name: Alex Sedique

Protocol #:

Project Title: COPING WITH EMERGING TECHNOLOGIES: BURDEN ON SCHOOL DISTRICT#S VISION, BUDGET, PLANNING, AND IMPLEMENTATION

School: Graduate School of Education and Psychology

Dear Alex Sedique:

Thank you for submitting your application for exempt review to Pepperdine University's Institutional Review Board (IRB). We appreciate the work you have done on your proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations 45 CFR 46.101 that govern the protections of human subjects.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit an amendment to the IRB. Since your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite the best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the IRB as soon as possible. We will ask for a complete written explanation of the event and your written response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the IRB and documenting the adverse event can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* at community.pepperdine.edu/irb.

Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval. Should you have additional questions or require clarification of the contents of this letter, please contact the IRB Office. On behalf of the IRB, I wish you success in this scholarly pursuit.

Sincerely,

Judy Ho, Ph.D., IRB Chair

APPENDIX D

Approvals for Citation

Alex Sedique 'student 9:49 PM (12 hours ago)

Dear

I am a doctoral student at Pepperdine University and I am in the process of writing my dissertation, which is survey design study that will ask school district technology leaders about their knowledge of teaching and technology.

I am asking for your permission to use part of your survey that you have used in your study: Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers. (2006). I will be modifying the survey slightly to adjust for the role of school district technology administrators.

In addition, with your permission I would like to use the graphic representation of the TPACK framework used in your website: http://tpack.org.

Thank you so much in advance for your kindness,

Alex N. Sedique
Doctoral Student
Pepperdine University
School of Education & Psychology

Matthew J Koehler 9:57 PM (12 hours ago)
to me

Categorize this message as: Personal — Never show this again

No permission is needed to use the survey — so your'e free to use it. Good luck!

As for the image, permission and guidelines here: http://tpack.org/using-the-tpack-image/

Good luck with your research,

Sincerely,

Dr. Matthew J. Koehler
Professor
Michigan State University

Dear Dr. Mishra,

I am a doctoral student at Pepperdine University and I am in the process of writing my dissertation, which is survey design study that will ask school district technology leaders about their knowledge of teaching and technology.

I am asking for your permission to use part of your survey that you have used in your study: Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers. (2006). I will be modifying the survey slightly to adjust for the role of school district technology administrators.

In addition, with your permission I would like to use the graphic representation of the TPACK framework used in your website: http://tpack.org.

Thank you so much in advance for your kindness,

Alex N. Sedique
Doctoral Student
Pepperdine University
School of Education & Psychology

Punya Mishra 9:29 AM (1 hour ago)
to me

Categorize this message as: Personal — Never show this again

Alex –

Thank you for your note.

Feel free to use the survey providing appropriate citation of the same.

The TPACK image is freely available to use – with information on citation provided at TPACK.org

All the best with your research.

~ punya
—
Punya Mishra
Associate Dean of Scholarship & Innovation
Mary Lou Fulton Teachers College
Arizona State University
education.asu.edu