BYOD: The PreK-12 Technology Leader's Perspective

By

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ABSTRACT

PreK-12 technology leaders are the men and women in senior-level school technology leadership positions. The role of the PreK-12 education technology leader is complex and serves as the centerpiece of school technology leadership. The purpose of this Q methodology study was to examine and emphasize the importance of PreK-12 technology leader perspectives of Bring Your Own Device (BYOD) programs.

The unique mix of data gathered in this study provides the information needed to answer the research questions posed; What are the benefits of BYOD from the PreK-12 technology leaders perspective and what are the drawbacks? The findings conclude that BYOD is seen as less of a pedagogical approach and more as a technical one that grants access to the school network and online resources. Technology's role in pedagogy is reflected in the benefits identified by participant viewpoints. The current study found that technology is viewed as improving collaboration, differentiation, and assessment methods. BYOD is seen as having many drawbacks like creating problems when students forget to charge their device, providing increased opportunities for hacking, creating excessive bandwidth usage, not providing a cost savings, exacerbating equitable access concerns, and not improving school-to-home communications. The current study indicates that some participants do not see BYOD itself providing benefits to teaching; they view technology in all its forms as being beneficial to instruction. This distinction is important because it provides evidence of a tarnished view of BYOD. Globally, participant views indicate that 1-to-1 technology programs are the preferred method of getting technology into the hands of students.

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DEDICATION

Dedicated to my family and friends for their love, inspiration, patience and support. A special dedication to my wife, Deborah. I could have found no better partner for life’s journey.

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The International Telecommunications Union (ITU), a United Nations agency for compiling Information and Communication Technologies (ICT) statistics, reported that in 2017 there were seven billion mobile phone subscribers worldwide, and tens of millions of new Internet users each year. In addition, hundreds of millions of people around the world, even in secluded areas, used satellite services (communications that occur between earth and one or more space-based satellite stations) for a wide variety of activities including surfing the Internet. In developed countries, nation states with a developed economy and robust technology infrastructure, 94% of youth aged 15-24 use the Internet (ITU, 2017). Even in developing countries Internet use by youth exceeds 66% (ITU, 2017). Worldwide, there are 830 million young people connected to the Internet (ITU, 2017). Nearly every facet of life depends on ICT including business operations, entertainment, culture, home life, and education (ITU, 2017). In schools, 97% percent of teachers report having one or more computers in their classroom every day and 96% of the computers in PreK-12 classrooms have Internet access (Gray, Thomas, & Lewis, 2010). Technology is ubiquitous throughout the lives of the youth attending PreK-12 schools.

International investors made $8.15 billion in investments in education technology in the first 10 months of 2017 (Riggs, 2018). The term education technology covers goods and services like network switching, wireless access, electronic devices, server infrastructure, mobile device management, productivity software, student information systems, security solutions, web applications, technology consulting and online resources used for teaching and learning. Predictions indicate that by 2020 the education technology market value will be around $252 billion (EdTechXGlobal, 2016). Given these statistics, it is reasonable to conclude that PreK-12 schools are spending a substantial amount of money on the technology used in their classrooms and offices. In fact, PreK-12 education technology leaders report plans to increase spending on laptop computers, desktop computers, Chromebooks, teacher professional development, digital projectors, digital curriculum content, online assessments, and Bring Your Own Device (BYOD) initiatives (Scaffhauser, 2016).

PreK-12 technology leaders are the men and women in a senior-level school leadership positions with the job title of Technology Coordinator, Chief Technology Officer (CTO), Chief Information Officer (CIO), or Technology Director (CoSN, 2017). PreK-12 education technology leaders are responsible for providing support for both the instructional technology and the technology used for administration of the school district (CoSN, 2017). As a result, the role of the PreK-12 education technology leader serves as the centerpiece of school technology leadership. As central figures responsible for school technology decision-making, the PreK-12 technology leaders' beliefs and values shape the decisions made regarding school-wide technology initiatives.

Technology initiatives like one-to-one (1-to-1) programs, where each student has his or her own device for learning, are increasingly popular in PreK-12 school districts (CoSN, 2017). These initiatives are seen as a way to give students immediate access to technology in order to promote 21st Century technology skills, which are the skills necessary to prepare students for life in a technology-driven world (Dede, 2010; Lapek, 2017, p. 25; van Laar, van Deusen, van Dijk, & de Haan, 2017). A traditional 1-to-1 technology initiative, in which the school pays for the device, software, and support, can be very expensive and is frequently viewed as fiscally unsustainable (Cavanagh, 2015; Cristol & Gimbert, 2014; Chou, Chang, & Lin, 2017; Kiger & Herro, 2015; Weston & Bain, 2010). BYOD initiatives which are considered a variation of the 1-to-1, or the mobile learning model, in which students and staff bring their personal laptops, Chromebooks, tablets, smartphones and eReaders to school (Alberta Education, 2012) are viewed as a way to get all of the benefits of 1-to-1 but at reduced costs to the school. With BYOD, the cost of the student device is completely the responsibility of the parents and students (Janssen & Phillipson, 2015).

Research suggests that technological determinism, a widely held belief that technology in and of itself creates change in society (Dafoe, 2015; de la Cruz Paragas, & Lin, 2016; Fisher, 2006; Salehan, Kim, & Lee, 2018; Smith & Marx, 1994; Webster 2017), effects the decisions schools make regarding technology purchasing (Fisher, 2006; Webster, 2017). Technological determinism in education asserts that learning outcomes are driven by the inherent characteristics of the technology itself, independent of teacher influences (Bigum, 1997, p. 249). It is believed that technology has the agency to materially change teaching and learning. Technology leaders in Webster's (2017) study felt pressure to keep up with changes in education technology or their students would be left behind. The pressure to provide up-to-the minute technology resulted in technology purchases that had no clear connection to curriculum, or instructional goals despite those same leaders self-reporting a belief that instructional needs should drive technology decision-making (Webster, 2017). PreK-12 technology leaders are under pressure by school administration, teachers, students, and parents to provide students with access to current technology resources. Consequently, technological determinism may be viewed as a factor shaping the decisions PreK-12 technology leaders make in providing access to those resources.

Schools view BYOD as a way to increase student access to technology and as a way to provide access to up-to-the-minute technologies that the school may not be able to afford. This begs the question, when technology is readily available, does it increase student achievement? After decades of research, there is no agreement on how much (or even if) technology use impacts student achievement. Some studies report small to moderate positive effects of technology use compared to no technology use. Other research reports no effect under similar conditions (Williams & Larwin, 2016). Despite the mixed findings, researchers often agree that other important factors play an important role in the successful implementation of technology. Student achievement does not improve by simply placing a student in front of a device (Adhikari, Mathrani, & Scogings, 2016). Researchers propose that factors such as self-efficacy, school culture, pedagogy, school leadership, support, professional development, fidelity of implementation, and technology beliefs combine to define the classroom practices which have a direct impact on student achievement (Ertmer & Ottenbriet-Leftwhich, 2010; Hew & Brush 2007; Li, 2014; Williams & Larwin, 2016) In an era of increasing pressure to provide students with 21st Century skills, the viewpoints of PreK-12 technology leaders supporting the technology initiatives connected with 21st Century instruction need to be examined.

Problem Statement

Presently, the existing literature does not examine PreK-12 technology leader perspectives regarding 21st Century learning initiatives. The Consortium for School

Networking (CoSN, 2017) reported that, in 2013, BYOD was the number one priority of K-12 technology leaders. In addition, BYOD initiatives have been a top 10 concern for K-12 technology leaders for four of the past five years. Implementation of BYOD is a reality for many school districts and the research on the impact of technology on student achievement indicates that factors such as technology beliefs play a role in amplifying the successful use of technology in the classroom (Ertmer & Ottenbriet-Leftwhich, 2010; Hew & Brush 2007; Hsu, 2016; Li, 2014; Williams & Larwin, 2016).

This study will examine the gap in the existing literature concerning PreK-12 technology leader beliefs about BYOD. Therefore, the current research will focus on understanding how PreK-12 technology leader perspectives related to the practice of BYOD impact their support of this technology program and, by extension, student achievement.

Purpose

The purpose of this study is to examine and emphasize the importance of PreK-12 technology leader perspectives on BYOD programs in an effort to provide insight into a topic missing from the pantheon of BYOD research.

Significance of the Study

In an age when technology use in schools is omnipresent and viewed as a way to promote 21st Century skills, school leaders view BYOD as an affordable option for providing universal access to technology and the electronic resources associated with said technology for their student bodies (Arnold, 2015; Ackerman & Krupp, 2012; Cavanagh, 2015; McLean, 2016; Nelson, 2012; Parsons & Adhikari, 2016; Traxler, 2016). The pressure to provide up-to-date universal technology access is an important driver of technology-purchasing in schools and decision-making by PreK-12 technology leaders (Bigum, 1997; Webster, 2017, p. 33).

As the central figure in school technology support, PreK-12 technology leaders are expected to oversee all aspects of school technology including developing and promoting a technology-use vision, leading technology integration in all areas of the organization, promoting equitable access to technology, leading technology-use innovations, and providing adequate access and support for technology integration. In addition, PreK-12 technology leaders report that their top three job priorities are providing enough network capacity, cyber security, and data-driven instruction and decision-making (CoSN, 2018). There were over 389 cyber security incidents in PreK-12 organizations between 2016 and the end of 2018 (K-12 Cybersecurity Resource Center, 2018). These incidents included cyber-attacks that involved the disclosure of personal data, ransomware attacks, and unauthorized disclosures or hacks that compromised personal data (K-12 Cybersecurity Resource Center, 2018). Network bandwidth determines if a student can access online resources and applications in order to participate in technology-rich learning activities. Effective teaching and learning demands network bandwidth at levels predicted to reach 1 Gbps per 1,000 students in 2018 (Fox, Waters, Fletcher, & Levin, 2012, p. 25). Increasingly, schools are involving PreK-12 technology leaders in decisions regarding digital content purchasing as schools realize that technical aspects are as important as price and pedagogy when it comes to digital content (CoSN, 2018, p. 12). Eighty-six percent of the PreK-12 technology leaders surveyed by CoSN in 2018 indicated at least a moderate involvement in digital content decision-making, which is an increase of 11% over the 2017 survey results. Among the varied and complex leadership activities expected of PreK-12 technology leaders, they are often tasked with supporting BYOD programs. Consequently, PreK-12 technology leader perspectives of BYOD programs have the potential to impact the decisions made that directly contribute to the success of a BYOD program. There is a need to better understand PreK-12 technology leader perspectives of BYOD programs in order for schools to manage the impact those beliefs might have on the success of their technology initiative. Moreover, few studies have addressed this issue. This study will attempt to provide insight into what PreK-12 technology leaders see as the benefits and the drawbacks of BYOD programs.

Research Design

This study used Q methodology, which is a mixed-methods research process defined as a standardized approach to research used to examine the views, beliefs, values, and perspectives of groups of people or individuals (Baker, 2013; Brown, 1980; Watts & Stenner, 2012). In Q methodology the standard unit of measure becomes the participants' subjective interpretation of a varied set of statements called a Q sample that the participants rank-order in a range from most agree to most disagree. The process of ranking the Q sample is called a Q-sort and it is the process by which Q methodology data are acquired. The Q sample is developed from a concourse, which is an all-encompassing collection of written statements taken from all possible statements on the topic under study (Baker, 2013; Brown, 1993; Watts & Stenner, 2012, p. 33). The focus in Q methodology is on the individual subjective perceptions of the participants regarding the sample statements and the extent to which they are similar or dissimilar to other participant perceptions (Brown, 1993, p. 95).

Developing a concourse is frequently an exercise in discourse between the researcher and the participants through instruments like surveys and interviews. However, the concourse can be developed using statements taken from an exhaustive examination of literature on the topic, photographs, artwork, music, or from the larger population being studied by way of surveyed feedback (Baker, 2013; Brown, 1993, p. 95). This study engaged in a discourse with its participants through a survey, and a review of the available literature, in an effort to build a concourse encompassing the totality of PreK-12 technology leaders' perspectives regarding BYOD.

PreK-12 technology leaders in the States of Ohio and Western Pennsylvania were asked to participate in this study using an online survey. The PreK-12 technology leaders throughout the State of Ohio were invited to participate in the survey using the state's technology coordinator email listserv, which is a software application that allows an email sender to send a single email to the list and then the software sends that email to all of the subscribers to the list. Western Pennsylvania technology leaders were contacted by email through one of Pennsylvania's 29 Intermediate Units (statewide education service agencies). Responses from this initial survey were used to identify the research participants and to develop the concourse used for the Q-sort. Semi-structured interviews with the participants, during the Q-sort process, were conducted for the purpose of informing the study's results.

Post Q-sort, the data were coded and collected. The data were examined and interpreted using the guidelines set forth by Watts and Stenner (2012). Q methodology was used to analyze the individual participant sorts. These results were synthesized with the qualitative data in an effort to address the research questions of the current investigation.

Research questions

This study will focus on the following questions:

1. What are the benefits of BYOD from the PreK-12 technology leader perspective?
2. What are the drawbacks of BYOD from the PreK-12 technology leader perspective?

The answers to these questions may be used to determine to what extent technology leader beliefs might need to be addressed when pursuing BYOD in the PreK-12 school environment.

Researcher's Role

In a qualitative or mixed-method study, the researcher is a key instrument of the research; the researcher influences what is being researched (Wellington & Szczerbinski, 2007). As a result, the researcher's perceptions and beliefs play a key role in shaping the nature of the study. A researcher's personal beliefs influence the research questions, participant selection, research methodology, and data analysis (Maxwell, 2012, p. 26). Therefore, a careful analysis of those beliefs helps to establish validity in an attempt to avoid a flawed study (Maxwell, 2012, p. 27).

To counteract validity threats, several strategies recommended by Maxwell (2012) were employed. The respondent validation technique was used. Participants were encouraged to validate (check) research data and conclusions. If the number of participants is large, this strategy can become unwieldy (Maxwell, 2012). Since Q methodology can be used with very small numbers of participants, this problem was not encountered.

Searching for discrepant evidence and negative cases is used to negate researcher bias. To employ this strategy, the researcher looks for cases that counteract emergent theory(ies) and attempts to use them as a check for flaws in research logic and methods (Maxwell, 2012, p. 127). Discrepant data have been reported.

Maxwell (2012) promoted the use of numbers (quantitative data) in qualitative research as a way to counteract validity threats. Providing numbers to correspond with claims provides support for those claims (Maxwell, 2012, p. 128). This is the value of a mixed-methods approach. Q methodology includes the use of quantitative data to help support the qualitative theories.

A fourth strategy may be employed if the participants include individuals with whom the researcher previously had professional contact. In these instances, a research assistant was used who was properly trained in Q methodology to conduct the data collection. The use of a research assistant in the data-gathering process provided control measures in an effort to diminish the potential for a reactivity threat.

Limitations

This research study was limited to Ohio and Pennsylvania PreK-12 technology leaders. The survey instrument contained a mixture of survey questions created by the CoSN for their annual K-12 IT leadership survey and survey items created by the researcher. This study is, in part, an analysis of those survey items. This Q methodology study measured the individual views, beliefs, and values of its participants. Q methodology is not used to estimate population statistics, therefore, generalizing the results to a larger population is considered problematic. The process of the Q-sort is a subjective one: the participant applies his/her own meanings to the items being sorted at the time of the sort. Consequently, the same items presented to a single participant at different times might produce different results. This does not indicate a problem with the reliability of Q methodology, but, reliability of the participant viewpoint (Watts & Stenner, 2012). Participant views are limited to the items presented and to the time and place they are presented. A Q methodology study relies on the honesty of the participant responses. There is a risk of researcher bias during the interpretation stage of a Q methodology study.

Definition of Key Terms

The following are the key terms used in this study:

- *21st Century Skills* - The skills necessary to prepare students for life in a technology-driven world (Dede, 2010; Lapek, 2017, p. 25; van Laar et al., 2017). Skills such as creativity, critical thinking, problem solving, communication, collaboration, emotional flexibility, self-direction, information media, and technology skills are viewed as critical in the 21st century.
- *Bring Your Own Device* (BYOD) - A variation of the 1-to-1 or the mobile learning model in which students and staff bring their personal laptops, Chromebooks, tablets, smartphones, and eReaders to school (Alberta Education,

2012; Burns-Sardone, 2014; Chou, Chang, & Lin, 2017; Hopkins, Sylvester, & Tate, 2013; Janssen & Phillipson, 2015; Kiger & Herro, 2015; McLean, 2016).

- *Concourse* – The universe of relevant statements on the topic being studied by a Q-methods research study (Baker, 2013; Brown, 1993; Watts & Stenner, 2012, p. 33).
- *Digital Divide*- A well-researched social phenomena that describes "the inequality of access to technologies" by relevant social groups (Adhikari et al., 2016, p. 325). Determining levels of access includes consideration for complex factors such as income, education level, control over technology, and the nature of technology usage (Adhikari et al., p. 325).
- *PreK-12 Technology Leader*- A senior-level position with a job title of Technology Coordinator, Chief Technology Officer (CTO), Chief Information Officer (CIO), or Technology Director. PreK-12 education technology leaders are responsible for providing support for both instructional technology and the technology used for administration of the school district (CoSN, 2017).
- *Q methodology* – A mixed-method research approach used to collect a shared set of viewpoints (Brown, 1993; Watts & Stenner, 2012). It is an objective way to analyze subjective viewpoints of persons using a representative sample of statements (Said & Stricklin, 2014, p. 22).
- *Q sample* – A collection of statements taken from the concourse that the participant rank-orders from most agree to least agree (Baker, 2013; Brown, 1993; Watts & Stenner, 2012).

- *Q-sort* – The process of sorting the Q sample statements in rank order on a continuum based on the participant's subjective viewpoint (Watts & Stenner, 2012, p. 16).
- *Social Construction of Technology (SCOT)* – A counter argument to the concept of technological determinism that places society in control of the advancement technology (Dafoe, 2015; Pannebecker, 1991);
- *Technological Determinism*- A widely held theory of technology change that concludes that technology change is inevitable, and that technology has agency to create change in society (Dafoe, 2015; de la Cruz Paragas & Lin, 2016; Fisher, 2006; Salehan et al., 2018; Smith & Marx, 1994; Webster 2017).
- *Technology Integration* – The incorporation of technology into classroom settings that, when used effectively, results in meaningful student-centered learning practices.

Chapter 2

Literature Review

Technology use is ubiquitous in the lives of the students and in the classrooms of PreK-12 schools. The pervasive nature of technology is reflected in competing theories about its role in society. The theory of technological determinism places technology as the driver of changes in society, whereas, SCOT gives agency to society over the nature of technology innovations. Schools view technology innovations as a way to achieve the goals espoused by 21st Century skills' frameworks. National and local leaders promote tech use in classrooms as a way to prepare students for the demands of today's society. In the school, the principal is often a key figure in promoting technology use. Part of the PreK-12 technology leader's job responsibilities are to assist other school leaders, such as principals, in promoting technology integration to enhance student-centered instruction. Forty years of research on technology use in schools reveals that technology use in schools either moderately improves student achievement or not at all. Barriers to technology use include access to technology (extrinsic), intrinsic things like belief systems, self-efficacy, and challenges, with design thinking. Through their leadership role, the PreK-12 technology leader has an impact on first- and second-order barriers to technology use. BYOD is seen, by technology leaders, as a way to provide access to technology in schools seeking to reduce student to computer ratios. BYOD facilitates a reduction in an important extrinsic barrier to technology integration, access to technology. A technology leader's beliefs impact his or her technology decision-making, which, in turn, shape the technology culture of the organization under his or her leadership.

Theoretical Framework

Technological determinism. Technological determinism is a widely-held view of the importance of technology to society. Technological determinism concludes that technology change is inevitable and that technology, alone, has the power to change society, including educational practices (Dafoe, 2015; de la Cruz Paragas & Lin, 2016; Fisher, 2006; Salehan et al., 2018; Smith & Marx, 1994; Oliver, 2011; Webster 2017). Technological determinism views technology as an important force in society, and, by extension, a driving force in history (Dafoe, 2015; de la Cruz Paragas & Lin, 2016; Salehan et al.; Smith & Marx, 1994, p. x). As a result, causal connections can be made between important technologies and historic social change. Technological determinism views the Gutenberg printing press as causing the Reformation; the Cotton Gin receives credit for starting the American Civil War; the railroad and telegraph receive credit for enabling America to fulfil its Manifest Destiny; likewise, the Internet is credited as the source of political reform in several Middle Eastern countries and computer technology is viewed as the vehicle that can radically transform education (Fisher, 2006; Salehan et al., p. 726; Smith & Marx, 1994, p. x). Simply stated, "Technological determinism implies a diminished human choice and responsibility in controlling technology" (Pannebecker, 1991, p. 3).

Technological determinism is often viewed by academics as having a dualistic nature. It is argued that technological determinism takes the form of either "hard determinism" or "soft determinism" (Dafoe, 2015; de la Cruz Paragas, & Lin, 2016, p. 1529; Salehan et al., 2018, p. 728; Smith & Marx, 1994, p. xii; Soderberg, 2013, p.

1285). Hard determinism is characterized by strict words (James, 1884, p. 2) such as causes, creates, wills, and necessitates. Hard determinism imbues technology with sufficient agency (power) to effect change in society (Dafoe, 2015; Salehan et al.; Smith & Marx, 1994; Soderberg, 2013). Hard determinism puts technology alone in the driver's seat of history (Smith & Marx, 1994, p. x).

Soft determinism is characterized by a belief that the effect of technology on society is dependent, in part, on societal action (Salehan et al., 2018; Smith & Marx, 1994; Oliver, 2011; Soderberg, 2013). In the soft determinists' view, the power of technology to change society is a product of the time and place in which it is introduced. In this way, technology shares the power to affect history with the society into which it has been introduced. The hard and the soft interpretations of technological determinism share a common linear view in which technology is seen as having a causal effect on society (Edwards, 2012, p. 9).

The concept of technological determinism has deep roots in American society. Merritt Roe Smith (1994) argued in the essay titled *Technological Determinism in American Culture* that the concept of technological determinism existed within several of the founding fathers of the United States of America. In the early days of the nation, Benjamin Franklin, Thomas Jefferson, and Alexander Hamilton expressed views that granted agency to the new mechanical technologies of their age (p. 3). Americans, at that time, were believers in progress and in humanity's capacity for moral and material improvement (Smith & Marx, 1994). Technology for early Americans equated to the pursuit of progress and in the betterment of society, including material riches (Smith & Marx, 1994, p. 3). Throughout American history, popular books, essays, paintings, magazines, photographs, and mass media have contributed to the pervasive belief that technology equates to progress and that it determines the course of human history.

The pervasive nature of technological determinism's place in society is evident in the business of advertising and marketing (Fisher, 2006; Jones & Bissell, 2011; Smith & Marx, 1994). Using well known psychological concepts, advertisements not only sell technology, itself, but also the view that technology is needed to improve one's life and society as a whole (Fisher, 2006; Smith & Marx, 1994). A good example of this type of associative advertising is the well-known Apple Computer Inc. "Think Different" advertising campaign of 1997. In its marketing campaign, Apple Computer Inc. associated its technology products with the images of historical visionaries like Mohandas Gandhi, John Lennon, Thomas Edison, Albert Einstein, and Pablo Picasso (Siltanen, 2011, para. 21). Through the power of association, Apple technology is seen as the equal of the world's great artists, musicians, inventors, thinkers, and civil rights leaders. Therefore, Apple technology has the power to alter society in the manner of Gandhi, Lennon, Edison, Einstein, and Picasso. The Think Different advertisements are a clear representation of the nature of technological determinism and its role in society.

Fisher (2006) argued that the prevalence of technology determinism in education, technology advertising, and in-school change agendas, like the 21st Century classroom agenda, result in "false certainties" (p. 297) that ascribe the power to change educational practice to the technology, itself, while ignoring the role of students, family members, teachers, administrators, and school district leadership. When technology is given agency to improve instruction on its own, vital context is stripped from the appraisal of the usefulness of that technology. In the classroom, application of technological determinism implies that, regardless of context, the homogeneous use of the technology will produce homogeneous results (Fisher, 2006, p. 297). Consequently, technological determinism is seen as discounting the complex nature of teaching and learning. Along with the concept of agency, the reductionist nature of technological determinism is at the center of the criticism of it and its role in society.

Social construction of technology. Technology agency equates to the extent to which society has control over technology, or, to what extent technology is in control of society (Dafoe, 2015, p. 1048). In the technological determinist view, technology is in control of societal progress. In the SCOT view, society determines the development and direction of technology innovations (Klein & Kleinman, 2002; Pannabecker, 1991; Yousefikhah, 2017). SCOT is a popular counter argument to the concept of technological determinism (Dafoe, 2015; Pannebecker, 1991; Yousefikhah, 2017). SCOT is a multi-directional model whose proponents argue provides a much more nuanced understanding of technology developments and their role in society when compared to the linear technological determinist model (Pinch & Bijker, 1984, p. 405).

The SCOT framework consists of multiple components that interact to influence the development of technology (Dafoe, 2015; Klein & Kleinman, 2002; Pinch & Bijker, 1984; Yousefikhah, 2017). The SCOT framework consists of the following:

- Relevant social groups – are the "institutions and organizations, as well as organized or unorganized groups of individuals" (Pinch & Bijker, 1984, p. 414) that share the same set of social meanings regarding a specific technology. For example, the military and mass-market consumers would both be relevant social groups with regards to Internet technology.

- Interpretive flexibility – multiple possible designs for technology are explored through the process of intergroup negotiations (Klein & Kleinman, 2002; Yousefikhah, 2017, p. 36). Regardless of what technology emerges from the design process, other designs that were evaluated as being possible and given a different set of group dynamics, might have been the emergent design. For example, the design of the smartphone has gone through many iterations; early popular models included physical keyboards while recent versions involve the use of touch screen technology. Each design is reflective of the time, place, and, most importantly, the expectations of the relevant social group to which it is introduced.
- Closure and stabilization – due to the multi-faceted nature of a multigroup design, controversy over the direction of new technology is a reality (Klein & Kleinman, 2002, p. 30). Closure and stabilization refer to the degree in which there is inter-group acceptance of the definition, specifications, and vison for the emergent technology (Klein & Kleinman, 2002, p. 30; Pinch & Bijker, 1984; Yousefikhah, 2017, p. 38).
- Wider context – "The wider sociopolitical milieu" (Pinch & Bijker, 1984, p. 428) that influences the meaning of the emergent technology. The cultural and political norms of a social group can affect the development of a given technology (Klein & Kleinman, 2002; Pinch & Bijker, 1984).

At its core, SCOT espouses the premise that technology evolves out of a complex relationship with society, not out of a linear connection to it like with the determinists' view (Edwards, 2012, p. 9). While SCOT is a much more nuanced framework for explaining the interactions of technology and society than that of technological determinism, it is not without its critics. SCOT has been criticized for being overly simplistic in its treatment of relevant social groups (Klein & Kleinman, 2002). SCOT treats all relevant groups as having equal influence over the design process. Critics point out that such a pluralistic view does not adequately account for real power dynamics between social groups (Klein & Kleinman, 2002, p. 30). SCOT does well to explain how technology comes into being, but it fails to adequately explain the social impacts of technology (Edwards, 2012, p. 10). In addition, Dafoe (2015) argued that SCOT scholars have gone too far in rejecting the concept of technological determinism (p. 1050). Dafoe (2015) contended that science and technology scholars need to find a middle ground between hard technological determinism and radical social constructivism (p. 1050). Technology has a profound effect on humanity and on the environment; it also is intertwined in how we interact as social beings (Yousefikhah, 2017, p. 32). The interconnectedness between the opposing concepts of technological determinism and social construction makes it a questionable proposition to take a hard stance on either theory.

Technology integration. Hew and Brush (2007) contended that "there is no clear standard definition of technology integration in K-12 schools" (p. 224). A review of the literature covering the topic of technology integration in schools provides credence to their declaration. There does not appear to be a standard definition, however, as Hew and Brush (2007) pointed out, themes emerge from the literature that paint a picture of what technology integration is believed to be by scholars and practitioners alike (p. 225).

Technology integration involves the incorporation of technology into classroom settings (Afshari, Bakar, Luan, Samah, & Fooi, 2009; Alenezi, 2017; Cuban, Kirkpatrick, & Peck, 2001; Ertmer, Ottenbreit-Leftwich, Inan, & Lowther, 2010; Sadik, Sendurur, & Sendurur, 2012; Makki, O'Neal, Cotten, & Rikard, 2018). Technology integration requires that computers and other communications' technologies be present in PreK-12 classrooms. The presence of technology is a key component of technology integration. Students and teachers must be able to access technology in order for it to be used (integrated) so it must be present in schools and in classrooms.

It is important to note that access to technology, alone, does not guarantee that it will lead to improved teaching practices (Ertmer et al., 2012; Inan, & Lowther, 2010, p. 147); there is not a causal relationship between the two variables. Larry Cuban (1986), in his book titled *Teachers and Machines: The Classroom Use of Technology Since 1920,* argued that, for the better part of the 20th Century, access to technology innovations such as radio, movies, filmstrips, educational television, and computers did little to alter classroom instruction. Very often these technologies were used by a few willing individuals or in "token compliance" (Cuban, 1986, p. 55) with superintendent or board of education mandates. Access to technology in the classroom simply creates the possibility of effective technology use for enhanced student learning (Kim, Kim, Lee, Spector, & DeMeester, 2013, p. 77).

Employing computer technology in meaningful teaching practices for the purpose of enhancing student learning (Alenezi, 2017; Christensen & Knezek, 2017; Cuban et al., 2001; Ertmer & Ottenbreit-Leftwich, 2010; Hsu, 2016; Inan & Lowther, 2010; Liu, 2011; Petko, 2012) is a second theme that emerges from the scholarly literature when looking to identify a standard definition of technology integration. Technology is viewed by education technology scholars as an important means of delivering instruction. The success of technology integration is frequently connected to how technology is used for teaching and learning (Alenzi, 2017, p. 1798; Liu, 2011). Technology use in classrooms includes endeavors such as administrative tasks, drill and practice, instructional delivery, online testing, communication, and the use of Internet-based resources (Afshari et al., 2009, p. 78; Ertmer & Ottenbreit-Leftwich, 2010). When technology is integrated successfully for instructional purposes, these endeavors result in "meaningful learning, defined as that which enables students to construct deep and connected knowledge, which can be applied to real situations" (Ertmer & Ottenbreit-Leftwich, 2010, p. 257). Successful technology integration depends on a wide variety of factors and the classroom instructor's ability to navigate multiple barriers. Consequently, defining technology integration involves much more than counting the number of accessible devices and determining how often they get used (Ertmer, 1999, p. 49).

The literature indicates that quality technology integration results in meaningful student-centered teaching practices (Afshari et al., 2009; Ertmer et al., 2012; Levin & Wadmany, 2008; McLean, 2016; Shin, Han, & Kim, 2014). Student-centered teaching practices are ones that afford a student agency in determining the nature and course of their own learning. Technology has the ability to grant students access to a world of information that fosters personal relevance in the learning process (Parsons & Adhikari, 2016). These meaningful technology integration practices align with 21st Century learning goals by "developing students' self-directed learning, collaboration, and problem-solving skills" (Ertmer et al., p. 432). Technology-enhanced learning practices provide an avenue for student use of digital skills to think critically about the world; it allows them to apply their skills to make sense of information and to create new knowledge (Parsons & Adhikari, 2016, p. 71).

Quality student-centered technology integration practices involve constructivist teaching pedagogies such as active learning, collaboration, problem solving, exploratory learning, and authenticity (Afshari et al., 2009; Cochrane, Antonczak, Keegan, & Narayan, 2014; Ertmer, 2010; Frank, Zhao, & Borman, 2004; Hsu, 2016; Levin & Wadmany, 2008; McLean, 2016; Penuel, 2006; Yuan-Hsuan Lee, Waxman, Jiun-Yu Wu, Michko, & Lin, 2013). When student-centered teaching practices are employed, technology is viewed as a partner in teaching and learning; it is not an isolated skill or destination. In a student-centered classroom, the teacher is not viewed as the sole authority for knowledge but as a facilitator guiding student learning through collaboration (Hsu, 2016). In these learning environments, technology is the students' lens on the world with the teacher providing understanding and guidance as the student navigates that world.

Hew and Brush (2007) recognized that technology integration lacked a standard definition by education technology scholars (p. 224). However, they determined that technology integration should be defined as the use of computing devices, or the Internet, for instructional purposes (p. 225). This definition has served scholars and researchers well and it has been an adequate definition of technology integration for many years. However, over a decade after their important work, a more expansive definition emerges from the literature as the result of a more evolved understanding of the phenomenon. Simply using technology for instructional purposes does not provide a rich enough description of the purpose of technology integration in today's classrooms. Therefore, a standard definition of technology integration is proposed as follows:

Technology integration – The incorporation of technology into classroom settings that, when used effectively, results in meaningful student-centered learning practices.

21st Century Learning

Nearly two decades before the end of the 20^{th} Century, the desire to teach technology skills in schools became a national priority (Culp, Honey, & Mandinach, 2005, p. 280). In 1983, the National Commission on Excellence in Education released a report titled *A Nation At Risk: The Imperative For Education Reform.* This report radically changed the education landscape in the United States for decades (Gerald, 2003; Graham, 2013). It contained, among its many observations, the conclusion that computers are "penetrating every aspect of our lives-homes, factories, and offices" (National Commission on Excellence in Education, 1983, p. 116). The Commission estimated that by the turn of the century millions of jobs would involve technology. The Commission recommended that high school graduates be able to use a computer to gather information, communicate, perform computation, to acquire knowledge, and perform tasks on the job (National Commission on Excellence in Education, 1983, p. 124).

Since that report was issued, the priority to get technology into school classrooms has been reflected in varied political initiatives. In the 1990s, local school districts were reportedly spending $4 billion a year on new technology. During that decade, President Clinton established the goal to get every school and library connected to the Internet by the year 2000 (Conte, 1998, p. 1). The Telecommunications Act of 1996 established funding, widely known as e-rate, to get schools connected to the Internet. The e-rate program has been very successful in getting virtually all schools connected to the Internet (Federal Communication Commission, [FCC], 2017). The Enhancing Education Through Technology Act of 2001's (EETT), part of the No Child Left Behind (2001) legislation, primary goal was to increase student achievement using technology. The majority of $3.4 billion in EETT funds were earmarked for state and local technology initiatives in high need school districts (U.S. Department of Education, 2009, p. 1). More recently, the Obama White House promoted science, technology, engineering, and math (STEM) education as a priority (STEM for All, 2016). In providing money for technology for schools through these initiatives, along with other technology initiatives funded at state and local levels, politicians and school boards have promoted what is commonly known as 21st Century skills. These 21st Century skills are viewed as the skills necessary to prepare students for life in a technology-driven world (Dede, 2010; Lapek, 2017, p. 25; van Laar et al., 2017).

Due to the paradigm shift in society that has resulted from the prominent role technology has taken in all aspects of peoples' lives, proponents of introducing 21st Century skills in education see the skills required in the 21st Century as significantly different than those required in the 20th Century (Dede, 2010; Kereluik, Mishra, Fahnoe, & Terry, 2013, p. 125; van Laar et al., 2017). "The call for 21st Century knowledge frameworks largely rests on the assertion that education has failed to prepare students for the demands of the 21st Century" (Kereluik et al., p. 128). One of the most widely adopted 21st Century skills' framework is the one developed by The Partnership for 21st Century Learning ([P21], Dede, 2010, p. 4; Kereluik et al.). P21 was founded in 2002 as the result of the No Child Left Behind Act of 2001 (Dede, 2010; Our History-P21, 2018).

P21 believes that when students are exposed to 21st Century skills they are much more prepared to succeed in the 21st Century globally-connected society. Their framework promotes the mastery of key subjects like mathematics, language arts, world languages, science, history, government, and civics. P21 advocates for entwining 21st Century themes like global awareness, entrepreneurial literacy, civic literacy, health literacy, and environmental literacy into the core subject areas. P21 also seeks to promote 21st Century skills in areas outside of core subjects. The skill areas beyond core subjects that the P21 framework (2007) promotes include the following:

- Learning and innovation skills – encompassing creativity, critical thinking, problem solving, communication & collaboration;
- Information, media, and technology skills – described as information literacy, media literacy and technology literacy; and
- Life and career skills – the social and emotional skills needed to participate in society like flexibility, initiative, self-direction, accountability, and leadership (P21, 2007, p. 2).

The International Society for Technology in Education ([ISTE], 2018a) is a non-profit organization founded to serve education technology stakeholders throughout the world (ISTE, 2018a). They are widely recognized for their technology frameworks used by education stakeholders. ISTE's (2018b) digital skills' frameworks include standards for student digital skills (ISTE, 2018b). The ISTE (2016) student framework was first developed in 1998 and has undergone multiple revisions to keep it relevant as technology evolves in society (Stager, 2007). ISTE (2018a) does not use the term 21st Century Skills to describe their framework. However, their core belief that students need to be prepared to succeed in a rapidly changing technology rich global society and an examination of the content of their standards reveal that their framework aligns with the goals of the 21st Century skills' movement. Consequently, their digital skills' framework can be viewed as part of the 21st Century skills' continuum (Dede, 2010). ISTE's (2016) seven 21st Century skills' attributes for students include the following:

- Empowered Learner - students are an active part of the learning process; they build/customize their own learning environments using technology to seek feedback and to demonstrate learning (p. 1).
- Digital Citizenship - students understand the responsibilities of living in a digital world (p. 1).
- Knowledge Constructor - students use technology to acquire knowledge, produce learning products, research effectively, evaluate the credibility of information (including media), and build knowledge through real world exploration (p. 1).
- Innovative Designer - students use technology to solve problems and to create solutions (p. 2).
- Computational Thinker - students use strategies to solve problems and use technology to develop and test solutions (p. 2).
- Creative Communicator - students clearly express themselves in creative ways using a variety of styles and formats (p. 2).
- Global Communicator - students use digital tools to collaborate and work with others effectively (ISTE, 2016, p. 2).

The overlap between P21's skills' framework and ISTE's (2016) student framework is evident. Both frameworks extoll the virtues of critical thinking, creativity, global mindedness, media skills, technology skills, persistence, and collaboration. However, they each have areas of distinction. P21 focuses more on social and emotional skills like flexibility and self-direction whereas the ISTE (2016) framework is grounded in a view of technology as a tool to assist the student in accomplishing a task that might not be possible without it (Dede, 2010, p. 9).

The State of Ohio and the State of Pennsylvania have adopted science and technology learning standards. Ohio's standards, written by the Ohio Department of Education (ODE) and adopted in 2017, cover a wide range of technology-learning expectations for students beginning in kindergarten through grade 12 (ODE, 2017). The Ohio standards are organized into three strands:

- Information and communications technology – this strand contains standards for identifying and using digital learning tools, communicating ideas and information (ODE, 2017, pp. 1-4).
- Society and technology – this strand contains learning standards covering concepts like understanding the interconnectedness of technology, society, and the natural world, specifically addressing the impact of technology on society (ODE, 2017, pp. 5-7).
- Design and technology- this strand addresses the role technology has in improving products and systems to meet the needs of society through the design process (ODE, 2017, pp. 8-11).

Pennsylvania's science and technology standards, authored by the Pennsylvania Department of Education (PDE) in 2002, cover a broad range of academic standards.

The PDE standards are intended to be taught only in grades 4, 7, 10, and 12. They cover eight academic content areas:

- Unifying themes – this standard covers the unifying science and technology themes of motion, forces, energy, structure of matter, change, and machines (PDE, 2002, p. 4).
- Inquiry and design- addresses the concepts of observing, classifying, inferring, measuring, computing, communicating, conducting scientific inquiry, interpreting data, and problem solving (PDE, 2002, p. 4);
- Biological sciences- this standard addresses living things, their lives, and the habitats in which they live (PDE, 2002, p. 4).
- Physical science, chemistry, and physics- cover the study of objects and their properties (PDE, 2002, p. 4);
- Earth sciences- "include the studies of forces of nature that build the earth and wear down the earth" (PDE, 2002, p. 5);
- Technology education- students develop skills to identify and use technology to solve problems that are encountered in real life (PDE, 2002, p. 5).
- Technology devices- students are expected to use technology to observe, measure, and make things. Technology is used to extend human abilities to collect and communicate information (PDE, 2002, p. 5).
- Science, technology, and human endeavors- Students study the interplay of technology and society through the lens of science (PDE, 2002, p. 5).

Ohio's and Pennsylvania's technology learning standards share similarities with 21[st] century learning frameworks. Each state expects students to use technology to solve problems, communicate, collaborate, and to better understand the role technology plays in society. However, each state takes a different approach to incorporating technology-learning in their schools. Ohio's technology-learning standards provide learning expectations for all grade levels, whereas Pennsylvania targets only four distinct grade levels. Ohio's technology standards are not directly connected with other academic content areas; however, Pennsylvania directly connects their technology standards to core science academic content.

Kereluik et al. (2013) analyzed 15- 21st Century learning frameworks. These researchers were looking for common characteristics contained in the 21st Century skills' frameworks that they examined in an effort to explain the 21st Century learning phenomena. The 15 frameworks analyzed by Kereluik et al. included reports from educational organizations, the Educational Testing Service (ETS), the Center for Public Education, ISTE (2016), the Partnership for 21st Century Skills (P21), the MacArthur Foundation, and corporations such as Cisco, Microsoft, and Intel, along with unique scholars such as Howard Gardner and Yong Zhao (Kereluik et al., 2013, p. 129). Kereluik et al. determined that three broad categories, each with three sub-categories, form the substance of the 21st Century frameworks in their study. The broad categories are identified as Foundational Knowledge, Meta Knowledge, and Humanistic Knowledge. The category of Foundational Knowledge describes the content knowledge that 21st Century students should know, and it is an outgrowth of three sub-categories that encompass digital/ICT literacy, core subject knowledge, and cross-disciplinary knowledge (p. 130). Meta Knowledge describes the content in the 21st Century frameworks that depicted students' actions such as creativity and innovation, problem solving, critical thinking, communication, and collaboration (p. 130). Humanistic Knowledge describes the content of the frameworks that involved students' engagement in life or social skills such as cultural competence, emotional awareness, and life/job skills (p. 131).

"Each of these major categories can be seen as what we need to know, how we act on that knowledge, and the values we bring to our knowledge and action" (Kereluik et al., 2013, p. 131). These researchers concluded that nothing in education has changed as the result of 21st Century skills' initiatives because what we know, how we act on what we know, and the values brought to bear by the learner have always been important (p. 131). They went on to delineate that while these skills have always been required, the urgency and form they take has been changed radically by technology. Kereluik et al. suggested that, while the 21st Century is different from past centuries, these differences are not manifest in the core education concepts - to know, to act, and to value (p. 133).

Criticism of 21st Century Learning

Critics of the 21st Century skills' initiative see them as providing nothing new to the education landscape (Greenlaw, 2015; Ravitch, 2010; Rotherham & Willingham, 2009; Kereluik et al., 2013). These critics argued that the 21st Century skills championed by the current movement have always been around and relevant (Greenlaw, 2015; Ravitch, 2010; Rotherham & Willingham, 2009; Kereluik et al.). It is argued that, throughout human history, education initiatives have repeatedly targeted things like:

- Career preparation, vocational, or life skills – Frequently, throughout the previous century, education innovations have included the belief that learning should reflect the real life of students (Ravitch, 2010, p. 13).
- Project-based exploratory learning – the concept of student-centered hands-on learning is not new. In 1918, the "Project Method" sought to engage students in hands-on sequential learning projects (Ravitch, 2010, p. 12).
- Collaborative group work – Cooperative social skills have been needed for human survival for millennia. They were a reoccurring theme in pre-21st Century education reform movements like the Project Method (1918) and activity movements of the early 20th century (Ravitch, 2010). Rotherham and Willingham (2009, p. 19) argued that skills like cooperation and self-direction require that teachers better understand these concepts in order to teach them effectively.
- Global awareness/ Information literacy - These skills are not new for the elite members of society (Rotherham & Willingham, 2009, p. 16). Success in society has always connected to an individual's ability to digest information and make decisions based on that information.
- Critical thinking skills – Problem-solving is not new. It has been a "component of human progress throughout history, from the development of early tools to agricultural advancements, to the invention of vaccines" (Ravitch, 2010; Rotherham & Willingham, 2009, p. 16).

Even though these skills are far from novel, they are all skills reflected in the 21st Century learning frameworks adopted by schools. Kereluik et al. (2013) proposed that one explanation for the recycling of skills' initiatives is the concept of chronocentrism, which they described "as the egotism that one's own generation is poised on the very cusp of history" (as cited on p. 127). In other words, each successive generation believes it has discovered something new, thus prompting the unconscious recycling of old ideas into brand new education reforms.

Greenlaw's (2015) critique of the 21st Century skills' movement provided a concise comparison of the traditional (20th Century) teacher-centered approach to instruction and the 21st Century skills' movement's student-centered (constructivist) approach. Greenlaw (2015) compared direct instruction (traditional) with the interactive exchange (21st Century) approach to pedagogy. The interactive exchange approach places the student in the center of pedagogy and the teacher in the role of facilitator. This approach is characterized by guiding questions, open dialogue, and project-based learning activities. In contrast, direct instruction is characterized by teacher-led activities in which the teacher directs the acquisition of knowledge (p. 897). Greenlaw (2015) contended that, while the interactive exchange approach has its merits, it is not substantial enough to assist students with making sense of the vast expanse of information currently available (p. 897). The argument is made that even in the 21st Century, expert teacher direction is needed lest learners become lost in the vast expanse of information at their fingertips. Greenlaw's (2015) argument aligned with other scholarly critics of the 21st Century skills' movement when they professed that the focus on information skills' acquisition over content knowledge is misguided

(Greenlaw, 2015, Kereluik et al., 2013; Terry, 2013; Ravitch, 2010; Rotherham & Willingham, 2009).

Indeed, critics contend that the 21st Century movement places too much emphasis on information management and knowledge acquisition skills over curricular content knowledge (Greenlaw, 2015, Kereluik et al., 2013; Ravitch, 2010; Rotherham & Willingham, 2009). The 21st Century movement is built on the idea that due to advancements in technology and the resultant connectedness of society, learning opportunities occur in a variety of novel ways. Specifically, 21st Century skills' proponents declare that the Internet offers society the collaborative means to learn regardless of time and place (Greenlaw, 2015, p. 900). It is believed by 21st Century skills' scholars that anytime/anyplace learning requires individuals to master information management and knowledge acquisition skills in an effort to make sense of the information so easily accessed on the Internet. This 21st Century skills'-oriented approach is deemed overly simplistic by its critics (Greenlaw, 2015, p. 898; Kereluik et al.) as it dismisses the need for the deep content knowledge required to make sense of the world (Ravitch, 2010; Rotherham & Willingham, 2009). Literature indicates that it is not enough just to place a student in front of a device with a problem to solve; teachers are needed to guide student considerations. Students need awareness of context like the historical background of the problem and must be guided through the diverse theories associated with the problem if they are to make sense of the information they have so easily gathered (Adhikari et al., 2016; Greenlaw, 2015, p. 897).

In addition, this overtly simplistic approach is inherently biased against the economically disadvantaged (Greenlaw, 2015; Rotherham & Willingham, 2009.)

Students who have the means to attend good schools, in economically developed countries, are afforded greater opportunity to encounter 21st Century teaching in technology rich classrooms (Greenlaw, 2015; Rotherham & Willingham, 2009.) According to the ITU (2017), there is a 28% difference in Internet usage by youth when comparing youth in developed countries with youth in developing countries. This discrepancy places children in developing countries on the wrong side of the digital divide.

The digital divide is an area of study that describes the inequalities faced by segments of the population with regards to accessing technology (Adhikari et al., 2016). Levels of technology access are affected by complex factors such as income, education level, control over technology, and the nature of technology usage (Adhikari et al.). Students in developing countries, due primarily to economics and education levels, have less access to technology than students in developed countries (Greenlaw, 2015, p. 900). As a result, these students do not have equal access to 21st Century teaching.

PreK-12 Instructional Technology Leadership

As a school building leader, a principal's perception of how technology is to be used is an important factor in successful technology integration (Dawson & Rakes, 2003; Garcia & Abrego, 2014; Levin & Schrum, 2012; Waxman, Boriack, Lee, & MacNeil, 2013). Among a wide variety of diverse duties, the school principal is also expected to be the instructional leader and must be actively involved in providing the necessary supports for teacher technology success (Dawson & Rakes, 2003). Principals can effectively provide these technology supports by establishing a shared technology vision, maintain a pro-technology school culture, model excellence in technology use, seek out innovation, lead purposeful technology change, and ensure/promote equitable access to digital resources for all learners (ISTE, 2009). For a principal to be able to achieve this level of technology leadership he or she requires their own source of training and support (Dawson & Rakes, 2003).

The CoSN (2017) K-12 technology leadership survey indicated that technology use is often supported at the district level through a senior-level position with a job title of Chief Technology Officer (CTO), Chief Information Officer (CIO), or Technology Director. Most PreK-12 education technology leaders are responsible for providing support for both the instructional technology and the technology used for administration of the school district (CoSN, 2017). As an influential organization in PreK-12 school technology leadership, the Consortium for School Networking (CoSN, 2018) has developed a framework of the essential skills needed by the K-12 CTO. The CoSN Certified Educational Technology Leader (CETL) framework encompasses three primary categories consisting of 10 skill areas (CoSN, 2015). The following are eight representative statements of the 30 essential skills a PreK-12 technology leader must employ as outlined in the CETL framework:

- The K-12 technology leader is expected to lead the integration of technology into all areas of the organization (p. 2).
- The K-12 technology leader is expected to work with other district leaders to identify the steps needed to meet strategic technology goals and to plan for technology budgets (p. 4).
- The K-12 technology leader will work to enable equitable access to technology for all stakeholders (p. 6).

- The K-12 technology leader will facilitate the policy development process and ensure policies support an appropriate learning environment (p. 6).
- The K-12 technology leader is expected to lead integration of technology with curriculum and pedagogy to promote an appropriate learning environment (p. 4).
- The K-12 technology leader should promote innovative teaching and learning (p. 7).
- The K-12 technology leader must collaborate with stakeholders to establish a comprehensive vision of technology use (p.10).
- The K-12 technology leader must manage all tasks related to the required technical systems, infrastructure, and devices used in the school district (p. 11).

Examining the CETL framework reveals that the role of the PreK-12 education technology leader serves as the centerpiece of school technology leadership. A reasonable assumption can also be made that while the PreK-12 education technology leader may have less direct impact on technology integration in the classroom than that of the building principal, who is the primary school-based instructional leader, a PreK-12 technology leader will likely have a much broader impact on instructional practice because of their role as support provider for teachers and school-based instructional leadership. This assumption may be more (or less) accurate based on the size of the school district. In a larger district, the PreK-12 education technology leader may rarely directly interact with teachers, whereas in a smaller district they are more likely to be in direct contact with teaching and learning. However, even in a large district, a PreK-12 technology leader often provides leadership for those individuals tasked with direct technology support to teachers such as principals.

Research indicates that other factors in addition to the skills the PreK-12 technology leader employs shape his or her technology decision-making and in turn shape the technology culture in the organization under his or her leadership. Webster (2017) argued that technological determinism is a dominate force in school technology decision-making, professional practice, and shapes school technology interactions. A PreK-12 school technology leader who has a technological determinist viewpoint believes that technology has its own autonomy in determining social change outside of society's control (Dafoe, 2015; de la Cruz Paragas & Lin, 2016; Fisher, 2006; Salehan et al., 2018; Smith & Marx, 1994; Webster 2017). In a Straussian-grounded theory study of 31 education technology leaders working in PreK-12 school districts in the state of Virginia, Webster (2017) examined whether technological determinism influenced the participants', technology directors', and technology coordinators' thinking about technology. Webster's (2017) findings indicated that his participants had strong technological determinism beliefs and that those beliefs manifested in pressure for schools to keep pace with technology change or be left behind. PreK-12 technology leaders in Webster's (2017) study also believed that educational goals and curriculum should be a primary factor in technology adoption. Webster (2017) theorized that the two competing beliefs, one espousing keeping pace with technology for technology's sake and the other in which technology adoption is driven by pedagogy, create cognitive dissonance in PreK-12 technology leaders (p. 33). The resulting pressure to keep up with technology pushes PreK-12 technology leaders to purchase and implement technology without alignment to clear educational goals (Webster, 2017, p. 33). Webster's (2017) study showed that a technology leader's philosophy regarding the nature of technology impacts school technology decision-making. A PreK-12 technology leader's belief shapes his or her approaches to technology decision-making and those decisions impact teaching and learning.

Technology and Student Achievement

In an age when nearly every classroom has a computer, knowing the impact computer instruction has on student achievement is vital (Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011, p. 16). An examination of multiple technology and student achievement-related studies indicates that there has been a meaningful amount of research done in this area. The research examined covers technology use and student achievement under a variety of conditions. While these conditions are not identical to BYOD, they share similar features making these studies worth examining. Some of the research looks at student achievement connected to 1-to-1 programs or with student achievement in more traditional (computer lab) technology-use settings. The CoSN (2018) considered BYOD to be a method for achieving 1-to-1 student to technology ratios not unlike a technology program in which the school provides the device (CoSN, 2018). The student achievement research conducted in 1-to-1 settings involves programs that allow students to take the school supplied device home with them much in the same way a BYOD would be used.

The second-order meta-analysis study conducted by Tamim et al., (2011) cited 25 meta-analysis studies that covered 1,055 primary studies on technology and student achievement. A study by Williams and Larwin (2016) cited 22 studies on the topic. The meta-analysis done by Yuan-Hsuan Lee et al. (2013) covered 58 studies on the effects of teaching and learning with technology, and Weston's & Bain's (2010) critique closely examined two high profile 1-to-1 initiatives in an attempt to identify the effect technology has on student achievement in the cases they investigated. Certainly, there is some overlap between all of these studies. However, just considering the Tamim et al. study, alone, which allowed for only 25% overlap between the meta-analysis examined, they had a minimum of 788 unique primary studies represented in their second-order meta-analysis. Considering all of this research and the wide variety of settings in which it was conducted it is reasonable to assume that there is a definitive answer to the question of whether or not technology increases student achievement and under what conditions.

However, all of this research does not reveal a definitive answer on the effects of technology use in schools. The results of these studies reveal a mix of positive learning outcomes with technology use and no difference in learning outcomes between technology use and non-technology use (Chen 2015; Cochrane et al., 2014; Inan & Lowther, 2010; Thomas & Munóz, 2016). Yuan-Hsuan Lee et al. (2013) reported that technology has a positive effect on student cognitive and affective outcomes. In particular, the effect size for cognitive outcomes in the Yuan-Hsuan Lee et al. (2013) study was .42, which can be interpreted as a moderate effect size (Field, 2015). This effect size was reported as being larger than in past meta-analysis. Yuan-Hsuan Lee et al. theorized that this slight increase in effect size is the result of the advancement of technology and the teaching practices related to technology use (p. 140). Tamim et al. (2011) also concluded that there is a moderate positive effect size in favor of technology use for instruction as compared to non-use of technology. They report effect sizes ranging from .29 to .42 depending on the moderator examined.

The Williams' and Larwin (2016) study examined 1-to-1 computing in the high school setting and its impact on student achievement through the use of Ohio Graduation Test (OGT) data for 24 Ohio schools paired with similar Ohio schools without 1-to-1 technology programs as controls. The data used covered multiple years, achievement in multiple academic content areas, achievement by demographic groups, and types of devices to see if they impact achievement differently. Only programs that allowed home use were studied. Williams and Larwin (2016) concluded that 1-to-1 technology use does not have an impact on the performance index scores of the participants. In addition, Williams and Larwin (2016) found no content area effect. They also reported that student demographics reveal no statistical differences between groups based on treatment, although, IEP students receiving the treatment did have higher scores. There was no difference between treatment and control based on the type of device used (Williams & Larwin, 2016).

Critics of classroom technology use contend that research on 1-to-1 technology programs has failed to show a connection between computer use and improved standardized test scores (Cuban, 2006; Weston & Bain, 2010). In the two high profile technology initiatives cited by Weston and Bain (2010), researchers found either no effect on student achievement or no sustainable effect. With so much research having been conducted, Tamim et al. (2011) argued that there is no need to further study student achievement with technology use versus no technology use (p. 16).

While the research does not universally agree on whether or not technology use has a positive impact on student achievement, many researchers do agree that there are other factors at play when it comes to effective technology use in schools (Ertmer, 2005;

Frank et al., 2004; Hew & Brush, 2007; Tamim et al., 2011; Williams & Larwin, 2016; Weston & Bain, 2010; Yuan-Hsuan Lee et al., 2013). Williams and Larwin (2016) proposed that the conflicting nature of these studies may be the result of the varied purposes schools have for implementing a program, varied levels of success in implementing the program, and the fidelity of implementation. It stands to reason that if schools implement BYOD for policy compliance reasons, as compared to making the move to online curriculum or the academic panacea of a seamless student-centered learning environment, that achievement effects would be varied. Not dissimilar to Williams and Larwin (2016), Tamim et al. (2011) supported the view that technology serves at the pleasure of instructional design, pedagogical approaches, and teacher practices (p. 17). Factors such as instructional goals, classroom practices, fidelity, teacher self-efficacy, access to technology, professional development, subject matter, school culture and teacher beliefs appear to exert influence over the impact technology has on student achievement (Chen, 2015; Ertmer, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Frank et al., 2004; Hew & Brush, 2007; Levin & Wadmany, 2008; Parsons & Adhikari, 2016; Tamim et al.; Williams & Larwin, 2016; Yuan-Hsuan Lee et al.).

Barriers to Technology Integration

Barriers to technology integration can be described as the circumstances present in the classroom that inhibit the successful implementation of technology (Makki et al., 2018, p. 91). Peggy Ertmer (1999) described these barriers in terms of first- and second-order barriers. First-order barriers are described as obstacles extrinsic to teachers (Ertmer, 1999; Prestridge, 2012; Vongkullukns, Xie, & Bowman, 2018). Therefore, first-order barriers are obstacles that are school- or institution-based over which a classroom instructor has little direct control.

In accordance with accepted research, first-order barriers include:

- lack of access to technology (Ertmer, 1999, p. 50; Ertmer et al., 2012, p. 423;
- little time to use technology (Ertmer, 1999, p. 50);
- absence of technical support (Ertmer, 1999, p. 50; Ertmer et al., 2012, p. 423);
- paucity of leadership support (Hew & Brush, 2007, p .228);
- availability of technology professional development (Ertmer, 1999, p. 50; Ertmer et al., 2012, p. 423); and
- inadequate presence of school-wide technology planning or a technology use vision (Hew & Brush, 2007, p. 228)

In naming these barriers as "first-order" (p. 48), Ertmer (1999) connected the concept of first- and second-order barriers to excepted theories regarding first- and second-order change. First- order change involves adjustments made by teachers that leave existing pedagogical beliefs unchallenged, while only incrementally improving current teaching practices (Ertmer, 1999). The connection made by Ertmer (1999) is a valid one, however, it can be useful to view technology-use impediments labeled as first-order (Ertmer, 1999, p. 48) as having been identified as such because they are the very first obstacles that must be overcome to advance the use of classroom technology for enhanced student-centered learning. Using this simplistic sequential view, it can be argued that technology must be present in the classroom, must have appropriate support mechanisms in place, and must provide teachers needed time to use technology in order for successful technology integration to occur.

Research indicates that a teacher's willingness to integrate technology can be determined by the availability of or even the perceived availability of technology resources in the school (Hew & Brush, 2007; Inan & Lowther, 2010; Makki et al., 2018). Vongkulluksn et al. (2018) explored the connections between the first-order barriers of technology access and support through the moderator of teacher beliefs. They found that teacher technology value beliefs impact the extent to which teachers internally convert actual school technology support into perceived technology support. Therefore, increasing access involves more than just providing more devices and better technology support, teacher technology value beliefs must also be considered when reducing first order barriers (Vongkulluksn et al.).

According to the latest data from the National Center for Education Statistics ([NCES], 2017), part of the research arm of the U.S. Department of Education, 71% of children aged 3 to 18 use the Internet somewhere in their life; 65% of the time, the location that they used the Internet was at school. NCES (2017) has determined that there is no measurable difference in Internet use at school when comparing race; White, Black, Hispanic and multi-racial students access the Internet at school equitably. In addition, "the percentage of children who used the Internet at school was generally higher for older children than for younger children" (NCES, 2017, p. 6). The data reported by NCES (2017) indicated one interesting exception in the data trend related to Internet use by older students. NCES (2017) stated that there was a higher percentage of middle school-aged children (ages 11 to 14) than high-school aged children (ages 15 to 18) using the Internet at school (72% vs. 69%). NCES (2017) determined no measurable differences in the percentages of children using the Internet at school when comparing family income or by level of education attained by parents.

The CoSN (2018) reported that 85% of the K-12 technology leaders they surveyed indicated they have already implemented 1-to-1 (1-to-1) in their school/district. CoSN (2018) noted that the most common 1-to-1 implementation occurs in middle schools (53%) with a projected increase in 1-to-1 in the middle grades of an additional 30% over the next year. The predominance of 1-to-1 in middle schools is a likely explanation for the Internet use exception reported by NCES (2017). In 2010, NCES (2017) reported that the student-to-computer ratio in all public schools, when considering access to classroom-based computers and computers brought into the classroom, was 1.7 to 1 (Gray et al., 2010). Considering Internet-use statistics, the prevalence of 1-to-1 technology in schools, and, historically low student-to-computer ratios, the data indicate that, for many PreK-12 teachers, access to technology is not a barrier for technology use. These data lead to the assumption that in a majority of PreK-12 classrooms first-order barriers related to access have been overcome (Ertmer et al., 2012, p. 432).

Teacher knowledge and skills associated with using technology in the classroom have been identified as an important barrier to the successful integration of technology (Blocher, Armfield, Sujo-Montes, Tucker, & Willis, 2011; Hew & Brush, 2007). Research indicates that teachers' classroom technology practices are influenced by self-efficacy and their beliefs about teaching with computers (Anderson & Maninger, 2007; Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017). Providing quality iterative professional development (PD) to pre-service and in-service teachers is believed to help improve teacher knowledge, technology skills, and self-efficacy, thereby reducing the effect these factors have on meaningful technology use in the classroom (Blocher et al.; Tondeur et al.; Levin & Wadmany, 2008). A synthesis of the research reveals three desirable elements in a technology PD model:

- PD activities with clear connections to pedagogy and related to content (Blocher et al., p. 167; Hew & Brush, 2007, p. 438, Tondeur et al., p. 569);
- a long-term iterative approach (Hur et al., 2016, p. 113; Tondeur et al., p. 570; Levin & Wadmany, 2008, p. 254); and
- the use of mentoring and modeling (Blocher et al., p. 167; Tondeur et al., p. 570; Levin & Wadmany, 2008, p. 254).

A PD model incorporating these elements connects existing teacher technology beliefs with a desired set of new beliefs and skills; it provides teachers with time to make the desired student-centered teaching changes and to get comfortable with the new role technology plays in the classroom. Through the use of mentoring and modeling, this framework for PD also builds in supports for a positive school-based technology use culture. The goal of technology PD should be to improve an instructor's comfort and confidence in using technology in the classroom. A teacher who has a greater personal competency with technology use is more likely to use technology in the classroom (Blocher et al., 2011, Prestridge, 2012). Long-term technology PD is necessary to afford change to teacher technology beliefs and pedagogical practices (Levin & Wadmany, 2008; Hur, Shannon, & Wolf, 2016). Research indicates that professional development is one of the most influential of the first-order barriers (Ertmer, Ottenbreit-Leftwich, & York, 2007). Providing teachers a one-day workshop will not make a difference. Good quality professional development takes time and effort, but it will also reduce influential barriers to technology integration.

Ertmer et al. (2012) cited surveys conducted by National Education Association (NEA) and corporate entities such as Computer Discount Warehouse-Government (CDW-G) as revealing that a majority of teachers self-report a relatively high level of technology knowledge, skills, and relevant training that pre-dispose successful technology integration (p. 425). Similarly, NCES (2017) cited that teachers reported that technology PD conducted prior to their 2009 survey was relevant, met their personal needs, and applied to the technology in use at their school (Gray et al., 2010, p. 4). This indicates that in many schools, teacher PD needs are being met and this important barrier is reduced.

Educational leadership, literature, school improvement writing, corporate leadership literature, and websites are loaded with theories on the importance of a clear vision for quality leadership and organizational improvement. Definitions of a shared vision tend to be very similar throughout the literature. Gurly, Peters, Collins, and Fifolt (2015) explained that a "vision statement provides stakeholders with a picture of what their ideal school and students will look like if educators are successful in working together to achieve that vision" (p. 223). A clear technology vision communicates the values, beliefs, and ideal technology future of the school.

Consequently, "one of the most important steps in achieving meaningful technology use is the development of a vision of how to use technology" (Ertmer, 1999, p. 54). When it comes to integrating technology into schools, having a clear, shared technology vision provides a meaningful guide post for the school's technology integration journey. A clear technology vision can orient decision-making and move the organization towards its ideal technology future. In their work published in the *Journal of Research on Technology in Education*, Gunn and Hollingsworth (2013) examined a school district's large-scale technology implementation over a three-year period. Their research indicated that the district, through the use of a multi-layered approach to integrating 21st Century knowledge skills and strategies into their classrooms, saw successful improvement in the implementation of 21st Century teaching methods. Part of this multi-layered approach was a focus on strong leadership. A key leadership component, embraced early on by the district, was the adoption of a white paper setting the technology vision (p. 205). This technology vision was monitored and supported by stakeholders from all divisions of the school district with advisory committees in every school (Gunn & Hollingsworth, 2013). Hall (2008) explained that the power of a shared technology vision only comes into being when that vision is "translated into concrete actions" (p. 42). Consequently, the lack of a shared technology vision and the concrete actions associated with that vision can be viewed as first order barrier to technology integration (Ertmer et al., 2012; Hew & Brush, 2007).

There are a variety of different support needs when it comes to successful technology integration. In accordance with accepted research, support for technology use in the classroom comes in many forms:

- Administrative – includes factors such as technology-use vision, adequate technology budget, adequate time, modeling, and professional praise/support (Hew & Brush, 2007, p. 228);

- Technological – includes educational technology leadership, computer, and network support personnel (Ertmer et al., 2012, p. 425; Inan & Lowther, 2010, p. 147);
- Professional- includes support like the implementation of technology planning committees, professional learning communities, mentoring, and the use of teacher leadership (Ertmer et al., p. 425); and
- Peer – includes the use of peer social networking both on-line and in person (Inan & Lowther, 2010, p. 147)

Technical support is cited as a barrier that has a major impact on technology integration. The Ertmer et al. (2012) study examined external constraints to technology integration (first-order barriers) using a multiple case-study method. Their study revealed that among the 12 cases studied, technical support had the second greatest impact on technology integration (p. 428). Schools combat this barrier by hiring support specialists, and by providing technology leadership (ISTE Technical Support, 2018b). The ISTE technical support guidelines (2018b) recommended that schools provide technical support at levels that address classroom needs in the following ways:

- infrastructure (network, cabling, server, computer, and electrical) support at levels that permit the desired level technology use;
- access to technology specialists; and
- diversifying the responsibilities of support personnel when it comes to technology use, integration, and support

Administrative factors such as adequate technology budget, adequate time, modeling, and professional praise/support can have a direct impact on classroom technology integration (Hur et al., 2016; Ertmer et al., 2012). Principals and their actions play a critical role in leading technology integration in school classrooms (Hur et al., p. 107). Research indicates that teachers need administrative leaders to convey a technology use vison, model appropriate technology use, and provide them with support when taking technology risks in order to reduce the impact these factors have as barriers to successful integration (Hur et al.; Wozney, Venkatesh, & Abrami, 2006).

ISTE's Essential Conditions (2018a) are the 14 elements that ISTE (2016) considers essential for technology integration to occur. Of the conditions ISTE (2018a) has determined as essential, 11 of them (78%) can be categorized as being related to first-order barriers. The remainder of ISTE's (2018a) essential conditions are connected to student outcomes and community engagement. There are, however, other significant barriers that need to be addressed when seeking successful classroom technology integration.

Second-order barriers are described as impediments intrinsic to teachers (Ertmer, 1999, p. 48) involving beliefs about teaching with technology and the extent to which teachers are comfortable welcoming technology into their classrooms (Makki et al., 2018, p. 91). Therefore, second-order barriers are ones that teachers have sufficient agency to address.

In accordance with accepted research, second-order barriers include:

- attitudes and beliefs about teaching with technology (Ertmer, 1999, p. 51; Ertmer & Ottenbreit-Leftwich, 2010, p. 262; Tondeur et al., 2017, p. 569);
- teacher self-efficacy related to technology knowledge and skills (Ertmer & Ottenbreit-Leftwich, 2010, p. 261); and
- school culture connected with teaching using technology (Frank et al., 2004; Ertmer & Ottenbreit-Leftwich, 2010, p. 264).

A case study conducted by Levin and Wadmany (2008) illustrated the complexity of the relationship between teachers' views on technology and the adaptations undergone when using technology for teaching and learning. Their study highlighted the emotional struggle and growth that teachers encounter when faced with the change technology brings to their classrooms. For technology adoption to occur, it is important that teachers can tolerate the uncertainty technology brings, both in lesson content and in pedagogical beliefs (Hew & Brush, 2006; Levin & Wadmany, 2008). It is equally important that teachers have a low tolerance for dissonance (Ertmer, 2005; Levin & Wadmany 2008). Dissonance is similar to what Heifetz (1994) described as the disequilibrium required to mobilize people to adapt or what Ertmer (2005) described as the challenging of beliefs. Dissonance (disequilibrium or the challenging of beliefs) provides a catalyst to move current teaching practices toward the desired goals of the school (Heifetz, 1994, p. 35; Ertmer, 2005, p. 32; Levin & Wadmany, 2008).

The social climate surrounding technology use in the classroom plays a role in its effective use (Frank et al., 2004). The most successful teachers in Levin's and Wadmany's (2008) study exhibited an appreciation for "learning in a community of learners" (p. 252). This study demonstrated how technology can affect and be affected by the culture and climate of the school. Teachers in the Levin and Wadmany (2008) study changed how they functioned and thought about their roles as teachers and the role of the technology in teaching and learning. "Teachers' knowledge and beliefs appear to interact with existing culture to create action" (Ertmer & Ottenbreit-Leftwich, 2010, p. 267).

"Schools are fundamentally social organizations" (Frank et al., 2004, p. 148). As such, schools typically rely on informal processes like teachers learning on their own or from each other during free time. These informal learning processes, self-reflection, and learning from others, can be essential in adopting innovations (Levin & Wadmany, 2008). Social support is critical to innovation, thereby making school culture an important factor in the effectiveness of technology integration (Frank et al.).

School culture is a potent combination of traditions, norms, values, and shared beliefs among individuals (Ertmer & Ottenbreit-Leftwich, 2010). Ertmer and Ottenbreit-Leftwich (2010, p. 264) cited research by Ponticell (2003) and Roehrig et al. (2007) which concluded that innovative teachers easily succumb to social pressures to conform. This occurs when more experienced teachers, who do not see the value in technology and have low-level technology skills or have had negative technology experiences, exert social pressure on the innovative teacher to conform to school cultural norms (Ertmer & Ottenbreit-Leftwich, 2010; Li, 2014; Hew & Brush, 2007). Internal beliefs' systems are believed to be a primary contributing factor effecting teacher technology integration efforts, and the words and personal beliefs of others have been connected to technology use by peers (Alenezi, 2017; Ertmer et al., 2007). A research study conducted by Ertmer et al. (2012) revealed that when a teacher's own beliefs did not impede integration, the attitudes and beliefs of others were a strong barrier to successful integration (p. 433). As a result, a supportive and collaborative environment has been identified as fostering successful technology integration (Ertmer et al.). Consequently, a school culture that is pro-technology is key in empowering teachers to integrate technology effectively (Ertmer & Ottenbreit-Leftwich, 2010; Gil-Flores, Rodríguez-Santero, & Torres-Gordillo, 2017).

Technology integration happens through the lens of school culture which has been demonstrated to affect what a teacher believes about teaching with technology. Therefore, it is critical to understand stakeholder beliefs in an effort to understand the impact that school culture can have on technology integration (Li, 2014, p. 377). Teacher attitudes and beliefs can be a major barrier to technology integration (Hew & Brush, 2007; Thomas & Munóz, 2016). In addition, Ertmer (2005) theorized that to get high-level technology integration teacher pedagogical beliefs must be addressed. Makki et al. (2018) examined data collected in a four-year study of technology use by 114 teachers in the southeastern United States to determine the extent to which high first-order barriers impact second-order barriers. They found that second-order barriers such as teacher attitudes, anxiety, and comfort levels significantly determined the likelihood of a teacher using computers in the classroom (Makki et al., p. 95). In addition, Vongkulluksn et al. (2018) found that teacher value beliefs regarding classroom technology have "a direct association with teachers' technology integration practice" (p. 79). Teachers who believe technology will enhance teaching and learning spend more time using technology in the classroom (Hew & Brush, 2007; Kim et al., 2013; Vongkulluksn et al.). Value beliefs are thought to be a stronger predictor of technology use than teacher ability beliefs (Vongkulluksn et al., p. 79).

Scholars have concluded that teacher technology beliefs shape technology use in the classroom (Ertmer et al., 2012; Hew & Brush, 2007; Kim et al., 2013; Vongkulluksn, et al., 2018). A teacher who believes technology is a "way to keep kids busy" (Hew & Brush, 2007, p. 229) will only use technology as an electronic babysitter or as a reward. A teacher with this belief does not see the relevance of technology integration (Hew & Brush, 2007). In addition, teachers who view technology only as a tool to cover curriculum or teachers who hold the view that other skills and content knowledge are more important may not use technology at all or only use it for low-level activities (Ertmer, 2005; Hew & Brush, 2007; Levin & Wadmany, 2008). Li (2014) provided the following teacher statements exemplifying teacher technology beliefs:

- "Teach a concept with technology only if it is necessary" (p. 388).
- "If good learning is not happening in the classroom already, how can the use of advanced technology help?" (p. 388)
- "Technology can overwhelm kids as well as teachers" (p. 389).
- "Students need to know all this material; it is better for me to spoon-feed them from a book" (p. 389).

Research indicates that low-level technology integration and the negative technology beliefs that drive it support a pedagogical framework that places the teacher at the center of learning. Li (2014) contended that this teacher-centered set of negative technology beliefs are born, at least in part, out of fear that technology will eventually replace the teacher (p. 393).

A more desirable set of technology integration beliefs puts the student at the center of teaching and learning (Ertmer et al., 2012). Teachers who view technology as a partner in teaching and learning, not just a tool, engage in constructivist methodologies like active learning, collaboration, exploratory learning, and authenticity (Cochran et al., 2014; Ertmer, 2010; Frank et al., 2004; Gil-Flores et al., 2017; Levin & Wadmany, 2008; McLean, 2016; Penuel, 2006; Yuan-Hsuan Lee et al., 2013). Technology becomes a partner in learning when it is valued and present in classroom practices. In this way technology is not considered an isolated skill or destination, it is a valued pedagogical practice. In a student-centered classroom, the teacher is not viewed as the sole authority for knowledge but as a facilitator guiding student learning through collaboration (Hsu, 2016). In a technology-infused, student-centered learning environment, technology becomes the students' lens on the world. In this type of learning environment, the teacher's role evolves into providing understanding and guidance as the student navigates their technology-rich world. This evolution demands that a teacher be willing, able, and supported in their quest to use available technology for enhanced student-centered learning.

Self-efficacy is a belief by individuals regarding their ability to complete a task or perform a specific behavior (Alenezi, 2017; Anderson & Maninger, 2007; Hsu, 2016; Zimmerman, Schunk, & DiBenedetto, 2017). A person's self-efficacy is connected to "cognitive judgments of personal capabilities" (Zimmerman et al., p. 317). In other words, self-efficacy is a measure of an individual's confidence in his or her ability in performing a task or behavior. Increased levels of perceived self-efficacy have been shown to be connected to higher task-performance levels and higher motivation in completing tasks (Bandura, 1990). Because self-efficacy is associated with the performance of specific tasks, the connection between self-efficacy and the performance of those tasks is easily observed (Zimmerman et al.). Consequently, an individual with a high degree of self-efficacy is likely to do well in the performance of those specific tasks and to persist in efforts to complete them (Bandura, 1990; Lee & Lee, 2014; Zimmerman et al.). In regard to technology integration, teachers' self-efficacy contains specific beliefs about what they are able to do with technology in their classrooms (Hsu, 2016, p. 31). The relationship of self-efficacy to technology integration has been determined, through accepted research, to represent a positive correlation (Alenezi, 2017, p. 1800). The more confident a teacher is with using technology for teaching and learning, the more likely he or she is to successfully integrate technology in his or her classroom (Alenezi, 2017; Anderson & Maninger, 2007; Ertmer & Ottenbreit-Leftwich, 2010; Gil-Flores et al., 2017; Hsu, 2016). Anderson and Maninger (2007) examined intended technology use in teaching by pre-service educators by comparing participant intentions (dependent variable) with three independent variables including self-efficacy. Their research revealed that self-efficacy made up 20% of the variance in participant intentions (p. 158). In another study, Wozeny, Venkatesh, and Abrami (2006) determined that teacher attitudes regarding their ability to successfully use technology, when combined with other mitigating factors, composed 33% of the variance observed regarding technology integration. In other words, both the Anderson and Maninger (2007) and the Wozeny et al. studies determined that self-efficacy was the best predictor of their participant's intentions to use technology in the classroom (p. 191). The results of these studies suggest that schools should exert time and resources towards increasing teacher confidence in using technology to better achieve technology enhanced student-centered learning practices (Ertmer & Ottenbreit-Leftwich, 2010; Gil-Flores et al.).

Since Peggy Ertmer's seminal work (1999), in which she defined first- and second-order barriers, much research has been conducted on both types of barriers. In the interim, first-order barriers have been reduced and scholars have provided educators with a much clearer understanding of the interplay between teacher beliefs, school culture, self-efficacy, and their impact on technology integration. This more evolved understanding of technology integration barriers has facilitated the development of technology integration frameworks such as the Substitution, Augmentation, Modification, and Redefinition (SAMR) model and the Technological Pedagogical Content Knowledge (TPCK or TPACK) model. SAMR is a four-level, taxonomy-based approach used to explain the selection, use, and evaluation of technology in PreK-12 classrooms (Hamilton, Rosenberg, & Akcaoglu, 2016, p. 433). TPACK is a framework designed to help educators make sense of technology integration by examining the interplay of technology, pedagogy, and content knowledge (Koehler, Mishra, & Cain, 2013). These frameworks are used to, both, explain and promote technology integration in PreK classrooms, but, they, along with first-and second-order barriers, may not fully explain how or when a teacher successfully integrates technology. It is posited that when first- and second-order barriers have been reduced, and, when teachers have the requisite knowledge required to integrate technology that successful technology integration still may not occur (Tsai & Chai, 2012, p. 1058). In their 2012 position paper, Tsai and Chai suggested the existence of a third-order barrier called "design thinking" to explain the phenomena of the creation of new pedagogical practices resulting from the desire for successful technology integration. Design thinking is a way of looking at existing technology barriers and instructional goals and then creating the pedagogical content needed to address them (Tsai & Chai, 2012, p. 1058). When design thinking is used, teachers are able to design instruction that makes use of technology "at the right time and right place" (Tsai & Chai, 2012, p. 1059).

Design thinking is not part of pre-service education for teachers; consequently, it is seen as a barrier to effective technology integration (Tsai & Chai, 2012). Makki et al. (2018) conducted a study to evaluate the effect of third-order barriers in classrooms with high first-order barriers. In their study, Makki et al. provided an intervention designed to improve their participants' design thinking capacity. Specifically, they used a team-based approach to facilitate the development of technology-rich lesson plans, assistance in problem solving, and the development of strategies for specific areas of technology integration (Makki et al., p. 92). Their results revealed that reducing third-order barriers increases a teacher's comfort level with using technology in the classroom. Comfort level or the belief in one's ability to successfully use technology is associated with the second-order barrier of self-efficacy, which is a significant predictor of a teacher's use of technology in the classroom. Makki et al. concluded that improving design thinking can reduce the effects of high first-order barriers and encourage successful technology integration.

When it comes to technology integration, what is more important: extrinsic first-order barriers? Intrinsic second-order barriers? Third-order design thinking? All of the above? It stands to reason that first-order barriers, such as having sufficient access to technology and the support needed to use it, are very important in providing the opportunity for successful integration. On the other hand, research indicates that even when teachers have access there is not a causal relationship between access and technology integration (Ertmer et al., 2007). Scholars propose that intrinsic barriers appear to be more important than extrinsic barriers when it comes to technology integration (Ertmer et al., 2007; Gil-Flores et al., 2017; Makki et al., 2018; Tsai & Chai, 2012). Still, it is hard to dismiss the role of extrinsic factors. Successful incorporation of technology into classroom settings that results in meaningful student-centered learning practices is likely a function of a complex array of factors that are as varied as the classroom settings in which they function. The scholarly work conducted on technology integration barriers is enlightening and can be used by schools to target interventions that could help them achieve their technology integration goals.

Bring Your Own Device (BYOD)

BYOD was originally identified in the business world, in 2009, by the Intel Corporation which noticed an increase in employee-owned devices in the workplace (Harkins, 2013; Burns-Sardone, 2014). Intel recognized that its employees were bringing their personal smartphones, tablets, and mobile devices to their jobs and decided to embrace this trend rather than exclude the practice as was common in other organizations (Harkins, 2013, para. 4). Intel found that embracing BYOD resulted in increased employee productivity, increased security response time, and greater control over unauthorized devices (Harkins, 2013; Burns-Sardone, 2014). The BYOD trend that was popularized by Intel in 2009 has spread throughout the business world. Downer and Bhattacharya (2015) indicated that in the six years following Intel's recognition of BYOD, industry reports revealed that 70% of businesses allowed their employees to bring their personal devices to work (para. 2).

The BYOD trend has also arrived in PreK-12 school districts during the past decade. The first school BYOD programs, like the one in Forsyth County, Georgia, began in 2009 with individual schools allowing personally owned devices (Lacey, 2014). These individual programs grew rapidly to include entire school districts (Lacey, 2014, p. 84). Forsyth County Schools are far from being alone in the pursuit of BYOD; many schools have implemented BYOD programs during the past decade. According to data released by Project Tomorrow (2012), 52% of district administrators surveyed in 2010 indicated that they would not allow BYOD; two years later that number had changed to 35%. In schools, BYOD is considered a variation of the one-to-one (1-to-1) or the mobile learning model in which students and staff bring their personal laptops, Chromebooks, tablets, smartphones, and eReaders to school (Alberta Education, 2012; Burns-Sardone, 2014; Chou, Chang, & Lin, 2017; Hopkins, Sylvester, & Tate, 2013; Janssen & Phillipson, 2015; Kiger & Herro, 2015; McLean, 2016). This personally-owned technology is then used in the classroom as part of the teaching and learning process.

There are different BYOD models schools follow when the decision to allow personal devices at school has been made (Janssen & Phillipson, 2015; McLean, 2016). One BYOD model allows students to bring any device they own to school (Cavanagh, 2015; Grant et al., 2015; Janssen & Phillipson, 2015; Pegrum, Oakley & Faulkner, 2013). In this wide-open model, any device the student owns, as long as it can be used to access lesson content, is permitted in the classroom. Janssen and Phillipson (2015) described this model as beneficial in that the costs and risks associated with owning the devices are completely the responsibility of the parents and students (para. 6). It may also reduce expenses for families who already own a device that can be used for instruction. Janssen and Phillipson (2015) pointed out that this wide-open model has the disadvantage of not affording the school control over the types and capabilities of the device a student brings to school (para. 6). This can have a negative impact on teaching and learning if the student owned device is unable to access lesson content or requires technical support.

Another BYOD model employed by schools is to require parents to purchase a specific model of device or purchase a device from an approved list of school supported devices (Grant et al., 2015; Janssen & Phillipson, 2015; McLean, 2016; Pegrum et al., 2013; Thompson, 2017). This specified-device model (Janssen & Phillipson, 2015, para. 5) guarantees that students have devices that are capable of accessing lesson content. This model also guarantees that the extra costs for a new device will be paid by families. Some school districts treat this device-purchase obligation much in the same way more traditional school supplies are treated; they publish an approved device list and expect students to bring the device with them to school. Other schools put together device-purchasing packages so that parents can purchase approved devices directly through the school (Janssen & Phillipson, 2015, para. 5; McLean, 2016). Sometimes these purchasing programs allow families to make payments or to lease the necessary technology equipment (Janssen & Phillipson, 2015; McLean, 2016).

Interest in using BYOD for teaching and learning grew steadily between 2013 and 2017. The CoSN (2017) K-12 IT Technology Leadership Survey reported that interest in starting BYOD initiatives in PreK-12 schools has been a top 10 concern for school technology leaders for the previous four years. In 2013, BYOD was the number one priority for the PreK-12 technology leaders surveyed by CoSN (2017), whereas, in 2017, BYOD was ranked ninth as a priority. CoSN's (2017) data suggested a continued decline in interest in BYOD among the school leaders surveyed. However, the percent of fully implemented BYOD programs reported to CoSN (2017) had grown from 17% to 24% over a four-year time span. Contrary to the trend of increasing use of BYOD in schools prior to 2017, CoSN (2017) reported a decrease in schools considering new BYOD initiatives. According to CoSN (2017), the decrease in priority level reflected the increasing number of schools that have fully implemented BYOD, the availability of inexpensive devices, interoperability, and concerns over equity.

CoSN (2017) considered BYOD as a way for schools to achieve their student-to-computer ratio goals. It is important to note that BYOD, not unlike a 1-to-1 technology program, is often discussed as part of the broader mobile learning category (Arnold, 2015; Christensen & Knezek, 2017; Cristol & Gimbert, 2014; Chou, Chang, & Lin, 2017; Cheng, Guan, & Chau, 2016; Gillies, 2016; Grant et al., 2015; Janssen & Phillipson, 2015; Merga, 2016; Pegrum et al., 2013; Traxler, 2016). In 2017, the mobile learning category was the number one priority of school technology leaders according to CoSN (2017) research.

How BYOD is addressed by school policy should be considered when examining interest in BYOD programs. School policies often allow student use of personal devices at the discretion of their teachers or policies allow student to use the devices between classes (CoSN, 2017). Only a small percentage of districts ban student devices completely (CoSN, 2018). CoSN (2018) reported that 67% of the districts that participated in their 2018 survey had policies that allowed students to use their devices at school. Taking this into account, along with a previously reported increase in fully implemented BYOD programs, it is reasonable to infer that interest in BYOD by PreK-12 institutions remains viable despite technology leaders reporting a waning interest in new initiatives.

Why Schools Implement BYOD

School districts are implementing BYOD for a variety of reasons. Financial reasons have been identified as a primary motivator for schools who consider BYOD (Arnold, 2015; Ackerman & Krupp, 2012; Cavanagh, 2015; Chernoff, 2018; McLean, 2016; Nelson, 2012; Parsons & Adhikari, 2016; Traxler, 2016; Weinstock, 2010). A more traditional 1-to-1 technology initiative, in which the school pays for the device along with software and support, can be very expensive and are often viewed as fiscally unsustainable (Cavanagh, 2015; Cristol & Gimbert, 2014; Chou, Chang & Lin, 2017; Kiger & Herro, 2015; Weston & Bain, 2010). Decreasing school technology budgets has also been identified as significant financial motivation for schools to engage with BYOD (Ackerman & Krupp, 2012; Project Tomorrow, 2012; Janssen & Phillipson, 2015). When the expenses of a traditional 1-to-1 technology initiative are combined with budget reductions, BYOD begins to look like a very appealing way to provide technology access for students. Consequently, schools view BYOD as a way to achieve 1-to-1 student-to-technology ratios, while offsetting device costs directly to students and their families (Cristol & Gimbert, 2014; Chernoff, 2018; Janssen & Phillipson, 2015; Merga, 2016).

An additional motivation for considering BYOD is the reality that students have increased access to their own technology devices to the point that it is omnipresent in their lives (Cheng et al., 2016; Cochrane et al., 2014; Kiger & Herro, 2015; McLean, 2016; Song, 2014; Thomas & Munóz, 2016; Traxler, 2016; Parsons & Adhikari, 2016;

Pegrum et al., 2013; Williams & Larwin, 2016). This omnipresence of technology has resulted in what Thomas and Munóz (2016) described as the new digital divide: a situation in which students have lower levels of technology access in school as compared to outside of school (p. 20). Traxler (2016) also described the phenomenon of having greater personal access to better technology outside of school as a motivating factor for BYOD in higher education. As a result, schools view BYOD as a way to provide students' access to newer technology at levels they are unable to provide.

Greater personal access to technology has also created conflict with school district electronic communication device (ECD) policies (Arnold, 2015; Quillen, 2011; Thomas & Munóz, 2016). Some BYOD policy experts recommend changing these types of policies to allow for the benefits of ECD use while avoiding possible abuses (Center for Education Policy and Law, 2011). School districts support BYOD in an effort to eliminate the conflict between old policies that ban ECD use and the reality that student access to technology is omnipresent. When schools attempt to regulate the technology use of their students through restrictive policies, the students frequently find ways around the rules governing technology use or those rules are erratically enforced creating subversive behavior (Arnold, 2015; Charles, 2012; Selwyn & Bulfin, 2016). A change in ECD policy avoids discipline referrals associated with ECD rule-breaking (Selwyn & Bulfin, 2016; Quillen, 2010).

BYOD programs also find a catalyst in the movement of school curriculum away from traditional text books towards digital resources. The pursuit of digital curriculum requires schools to consider the use of either proprietary digital content, which is paid curriculum content curated by experts, and open education resources (OER) which are freely accessible to schools (CoSN, 2017; Parsons & Adhikari, 2016; Weinstock, 2010). This movement towards online curriculum, using either proprietary or OER content, requires that PreK-12 students have access to a device so that they can access the digital learning resources. Consequently, schools view BYOD as a way to construct access to those resources.

One additional reason for implementing BYOD is to improve academic achievement. Scholars believe that BYOD can improve academic achievement by creating a seamless learning environment (Adhikari, Scogings, Mathrani, & Sofat, 2017; Song, 2014). A seamless learning environment, also known as ubiquitous learning, is characterized by the ability for students to learn anytime and anywhere using technology (Adhikari et al.; Chen, 2015; Cristol & Gimbert, 2014; Crompton, Burke, & Gregory, 2017; Gillies, 2016; McLean, 2016; Parsons & Adhikari, 2016; Song, 2014; Thomas & Munóz, 2016). To participate in the seamless learning environment, students must have access to technology at school and outside of school. BYOD, like other mobile learning programs and a 1-to-1 program with take-home privileges, is one way to provide universal access. In a review of research conducted on mobile learning, Crompton et al. looked at 113 mobile learning studies. Of those studies, 27% took place in a seamless learning environment. This significant percentage of studies indicates that researchers and their participants are interested in looking at ways mobile devices can be used seamlessly regardless of space and time (2017).

The role of student agency, the extent to which students are afforded the power to determine the nature and course of their own learning, is evident with BYOD (Parsons & Adhikari, 2016). Agency is connected to a desirable student-centered pedagogy. Agency in BYOD emanates from the central notion of BYOD. With BYOD, students own the device. This provides not only an expanded presence of that device in the life of the student, but also control over the device and how it is used (Parsons & Adhikari, 2016). BYOD is believed to facilitate access to classroom resources, improve communication, and provide a more engaging learning environment (Mclean, 2016; Parsons & Adhikari, 2016). In these ways, BYOD promotes student agency in the learning process. As previously noted, agency is a key component in student-centered pedagogical practices.

Parsons and Adhikari (2016) cautioned that "BYOD can only take place within the context of certain enablers" (p. 67). These enablers include policies and procedures, use expectations, and infrastructure support along with appropriate curriculum (Parsons & Adhikari, 2016, p. 67). Stakeholder involvement in the process is also critically important to BYOD implementation as BYOD, by definition, includes the use of personal devices by critical stakeholders in the teaching and learning process (Parsons & Adhikari, 2016), thereby, making teacher perspectives on the benefits and constraints of BYOD relevant to successful implementation.

BYOD from the Teacher's Perspective

As the leader in the classroom, teachers have a direct effect on the classroom environment. As already established, extensive research indicates that internal teacher characteristics like technology beliefs are central to successful classroom technology integration (Admiraal et al., 2017; Chen, 2008; Ertmer & Ottenbreit-Leftwich, 2010; Gil-Flores et al., 2017; Glassett, 2007; Hermans, Tondeur, van Braak, & Valcke, 2008; Hew, & Brush 2007; Kim et al., 2013; Liu, 2011; Petko, 2012; Prestridge, 2012; Vongkulluksn et al., 2018). Self -efficacy beliefs, alone, are thought to make up as much as 33% of the variance affecting technology integration (Wozeny et al., 2006). Kim et al. conducted a four-year study of teachers associated with the Comprehensive School Reform program funded by the U.S. Department of Education. Their study "found that teachers' beliefs about the nature of knowledge and learning and beliefs about effective ways of teaching were related to their technology integration practices" (Kim et al., p. 82). Accepted research suggests that teacher beliefs should be considered in order to promote successful technology integration (Hermans et al., 2008; Kim et al.). Consequently, teacher beliefs about BYOD are a critical component in the success of any BYOD program (Arnold, 2015; Bebell & Kay, 2010; Song & Kong, 2017). Teacher perspectives on BYOD have been studied in multiple contexts; Adhikari et al. (2017) and Adhikari and Parsons (2016) studied BYOD in New Zealand secondary schools. Song and Kong (2017) and Gillies (2016) studied teacher perceptions of BYOD in higher education. Their scholarly work provided insight regarding the benefits and constraints of BYOD from the teacher's perspective.

In accordance with accepted research, teacher beliefs about the constraints of BYOD include:

- classroom management problems (Arnold, 2015, p. 88; Nelson, 2012, p. 15);
- tech support problems (Gillies, 2016; Nelson, 2012, p. 15; O'Sullivan-Donnell, 2013, p. 34);
- increased opportunity for cheating (Nelson, 2012, p. 15; O'Sullivan-Donnell, 2013, p. 34);
- the need for uniform devices (Nelson, 2012, p. 15; O'Sullivan-Donnell, 2013, p. 34; Song & Kong, 2017, p. 43);

- access equity (Adhikari et al., 2017, p. 296; Arnold, 2015, p. 105; Gillies, 2016; Hurston, 2017, p.119; Nelson, 2012, p. 15; Song & Kong, 2017, p. 43);
- distraction of the device (Arnold, 2015, p. 100; Gillies, 2016; Hurston, 2017, p.118; O'Sullivan-Donnell, 2013, p. 28);
- risk of theft (O'Sullivan-Donnell, 2013, p. 34);
- lack of BYOD professional development (Arnold, 2015, p. 88);
- lack of standardized software resources (Adhikari et al., 2017, p. 296); and
- connectivity concerns such as wireless availability and network bandwidth limitations (Adhikari et al., p. 296; Arnold, 2015, p. 88; Hurston, 2017, p.120; O'Sullivan-Donnell, 2013, p. 34; Song & Kong, 2017, p. 43; Traxler, 2016)

Schools manage these concerns in a variety of ways. Schools provide devices for students who cannot afford them, adapt technology support levels and roles, increase (or throttle) bandwidth, provide robust wireless access, set usage expectations, provide relevant professional development, define BYOD policy, and purchase device agnostic (open standards) curriculum (Hurston, 2017; O'Sullivan-Donnell, 2013; Santos, Bocheco, & Habak, 2018; Tondeur et al., 2017; Traxler, 2010; Woodside & Sharam, 2014; CoSN, 2017). However, when equity concerns are paired with the need for uniform devices, these concerns drive schools away from BYOD towards consideration of a 1-to-1 program (Chernoff, 2018, p. 134; CoSN, 2018).

In accordance with accepted research, teacher beliefs about the benefits of BYOD include:

- use of real-world tools that students already have (Nelson, 2012, p. 15; Pascopella, 2009, p. 42);
- seamless access to learning resources, anytime/anywhere on their own device (Nelson, 2012, p. 14; Song, 2014, p. 59);
- instant access to information (Hurston, 2017, p. 116; Winterhalder, 2017, p. 157);
- improved student engagement (Hurston, 2017, p. 117; Song, 2014, p.59; Winterhalder, 2017, p. 157);
- personalized learning (Song, 2014, p.59);
- collaboration and communication (Pascopella, 2009, p. 42; Song & Kong, 2017, p. 42; Winterhalder, 2017, p. 157); and
- BYOD assistance with student-centered pedagogical practices (Winterhalder, 2017, p. 157).

Teachers play a central role in integrating BYOD in the classroom. Their beliefs regarding the value student-owned devices bring to the classroom affect how readily they are used for BYOD supported learning (Song & Kong, 2017). Research indicates that BYOD benefits, either real or perceived, influence teaching and learning activities as long as the school environment enables BYOD (Song & Kong, 2017). The benefits of BYOD co-exist with the constraints of BYOD to affect learning activities. BYOD benefits such as seamless learning, collaboration, improved communication, and student engagement become stifled when coupled with constraints like equitable access and connectivity concerns (Song & Kong, 2017, p. 45). This indicates that schools implementing a BYOD initiative should address BYOD concerns before implementation. Developing a BYOD strategy that addresses BYOD constraints and amplifies the benefits, when combined with parent and community input, may be a better alternative to increase technology use than a school-provided 1-to-1 technology program (Hopkins, Sylvester, & Tate, 2013, p. 9).

Chapter 3

Methodology

This study examined the perspectives of Ohio and Pennsylvania PreK-12 technology leaders regarding BYOD. Using the Q methodology, a mixed-methods research process, the study attempted to ascertain what Ohio and Pennsylvania PreK-12 12 technology leader views are regarding the benefits of BYOD and what they see as the challenges that BYOD presents. This study is designed to explore the viewpoints of individuals. Consequently, the Q methodology is an ideal research methodology. An explanation of Q methodology, the instrumentation used, participants, and the steps followed are provided.

Research Design

Q methodology has been used to investigate a wide range of subjects in psychology, political science, communication, the health sciences, and education (Brown, 2017). Q methodology is considered a highly effective research method (Watts & Stenner, 2012). It is defined as a standardized approach to research used to examine the views, beliefs, values, and perspectives of people (Baker, 2013; Brown, 1980; Watts & Stenner, 2012). Simply stated, Q methodology is an objective way to analyze subjective viewpoints of persons using a representative sample of statements (Said & Stricklin, 2014, p. 22). The Q methodology can be used with a single person or, more customarily, with a group of individuals (Watts & Stenner, 2012, p. 16).

Q methodology is a research approach originating from the work of William Stephenson, a British physicist and psychologist, beginning with the publication of a letter to journal *Nature* in 1935 and continuing until his death in 1989 (Brown, 1993; Watts & Stenner, 2012). Initially, Q methodology was an extension of Spearman's factor analysis (R methodology), in which a number of individuals each have been measured in a number of tests. Then, correlations for these variables are subjected to factor analysis (Watts & Stenner, 2012, p. 10). With Q methodology, the focus of the analysis shifts from the correlation of the variables (or attributes) to a focus on the individual's perception of a set of attributes. Watts and Stenner (2012) referred to this shift in focus as an inversion of R methodology in which "by person" (p. 12) analysis can be run in addition to traditional variable analysis.

Simply inverting the rows and columns of data, as espoused by Cyril Burt, a contemporary of Stephenson, failed to create acceptable results because it did not account for the need for a single unit of measure throughout the data (Watts & Stenner, 2012, p. 13). Stephenson corrected this failure by developing a procedure in which the data needed for Q methodology is measured subjectively by the participants involved in the study. In Q methodology, the standard unit of measure becomes the participants' subjective interpretation of a varied set of statements, called a Q sample, that the participant rank-orders in a range from most agree to most disagree. The process of ranking the Q sample is called a Q-sort and it is the process by which Q methodology data are acquired.

Subjectivity in the Q methodology provides the researcher with a variety of views from individuals that are subsequently analyzed to identify shared characteristics and the rationale behind why the individuals have those views, beliefs, or perceptions (Brown, 1993; Watts & Stenner, 2012). Subjectivity emerges from the participants (sorters) who are providing the researcher with their individual points of view on the topic of interest (Brown, 1993). The focus in Q methodology is on the individual perceptions and the extent to which they are similar, or dissimilar, to others (Brown, 1993). Consequently, Q methodology reveals the shared viewpoints of a group of individuals on any research topic making it an ideal method of research for this study.

Research Questions

Maxwell (2012) stated that research questions differ from research hypotheses in that research questions are an expression of what one wishes to learn; whereas, research hypotheses are a declaration of answers to those questions based on a number of factors (p.77). This study does not employ the use of a research hypotheses, but it does investigate the following research questions:

1. What are the benefits of BYOD from the PreK-12 technology leader perspective?
2. What are the drawbacks of BYOD from the PreK-12 technology leader perspective?

Watts and Stenner (2012) recommended that a research question employed in Q methodology research be simple so to avoid ambiguity (p. 53). It should allow the sorter to sort the Q sample along a single, understandable dimension from most agree to most disagree or most important to least important (Watts & Stenner, 2012). The research questions engaged by this study simply ask the participants their perception of the value of BYOD in the PreK-12 education setting.

Setting and participants

Typically, in R methodology, studies of large numbers of individuals are sampled and tested as an approximation of the general population. With Q methodology, the connection between subjects and testing are reversed. Consequently, only a few participants are required for a Q method study (Brown, 1980). In Q methodology, participant selection is not random but is "a structured sample of respondents who are theoretically relevant to the problem under consideration" (Brown, 1980, p. 192). The participants selected are expected to have a viewpoint relative to the topic being studied. As a result, they should help to define the topic of research (Brown, 1980).

The researcher asked PreK-12 technology leaders in the State of Ohio and Pennsylvania to participate in this study using an on-line survey. The survey was used as a way to develop the study's concourse and to collect demographic data. Invitations to participate in the survey were sent to a broad-based set of PreK-12 leaders. The researcher sent invitations to technology leaders throughout the State of Ohio using the state's technology coordinator email listserv, and, in Pennsylvania, using email contacts through one of Pennsylvania's Intermediate Service Units (IUs). The Ohio Technology Coordinators listserv is a voluntary email group used by Ohio's technology leaders to discuss topics of interest and to collaborate on issues impacting PreK-12 technology use in the state. Pennsylvania's 29 IUs provide education services such as mental health services, fiscal services, school improvement supports, special education services, and technology support to most schools throughout the state (Pennsylvania Association of Intermediate Units, 2014-2018). In addition, responses from the online survey were used to identify Q-sort participants.

Instrumentation

Survey Monkey was chosen as an online survey tool because it allows for easy data collection from geographically diverse participants and it allows for efficient statistical analysis. The researcher borrowed 15 survey questions from the CoSN (2018) K-12 Technology Leadership Survey and constructed 51 researcher-created questions to form the on-line survey. The majority of the questions, 58%, addressed participant views on BYOD. Sixteen-percent of the survey questions addressed participant views regarding technology determinism. The remainder of the survey questions, 27%, were used to gather demographic and technology leadership responsibilities' data.

Thirty-five of the 41 BYOD questions used a Likert- type scale on a continuum from 1 (strongly agree) to 5 (strongly disagree). These questions included positive perceptions and negative perceptions of BYOD.

Examples of positive Likert-type survey items assessing participant perceptions of BYOD:

1. BYOD is a cost-effective way for schools to save money on technology.
2. Students' personal devices are often more cutting-edge, allowing schools to more easily stay up-to-date with technology.
3. With BYOD, students are more likely to continue learning outside of school.
4. Students are already familiar and comfortable using their own technology, so they can focus on actually learning with them rather than learning how to use the device.
5. BYOD promotes more opportunities for individualized learning. This provides students with the opportunity to perform at their own pace.

Examples of negative Likert-type survey items assessing participant perceptions of BYOD:

1. I'm not sure why a school/district needs BYOD.
2. BYOD allows students to easily cheat on their assignments.
3. BYOD contributes to the unhealthy habit of too much screen time.
4. Many families cannot afford BYOD devices.
5. BYOD offers little improvement over traditional teacher led instruction.

In the on-line survey, the Likert-type questions were followed by open-ended response questions asking participants to describe what they see as the benefits of BYOD, drawbacks of BYOD, and their thoughts regarding BYOD as a way to improve instruction. The Likert-type questions were combined with participant responses to the open-ended questions and viewpoints taken from existing scholarly work to inform the concourse used in the current study.

As with the BYOD survey items, the technology determinism related survey items use a Likert-type scale on a continuum from 1 (strongly agree) to 5 (strongly disagree). These items are used to identify participant views regarding technology determinism.

Likert-type survey items assessing participant perceptions of technology determinism:

1. Technology has the power to alter the very essence of daily life.
2. Society is dependent on technology. As a result, technology is key in maintaining social order.
3. Machines make history by changing the material conditions of human existence. Through technology human existence is altered economically, spiritually, and morally.
4. Technology is the product of human actions - its power to change society is a product of the time and place in which it is introduced.

5. Society controls and shapes the impact of technology on daily life.

6. Technology equals progress.

7. Technology has little material impact on daily life.

8. Technology exerts a weak influence on social order when compared to other factors.

In the survey used, the technology determinism Likert-type questions were followed by open-ended response questions asking for participant views on the role of technology in society and in education.

In total, the survey used by the current study provided a solid base of participant views with which to build the study's concourse.

The Concourse

Presence, according to Robert Starratt, is dialogic in nature (Grogan, 2013). Presence, therefore, requires a two-party give-and-take to exist. This two-party give-and-take between the self and the other (a person other than one-self) is based on mutual and authentic communication. Through its dialogic nature, presence exists as a full awareness, through a variety of mediums, of oneself and others. Presence suggests full attention to the other and a deeper knowledge of oneself (Grogan, 2013).

Developing a concourse is often an exercise in dialogic discourse between the researcher and the participants through surveys and interviews. A concourse is an all-encompassing collection of written statements from which the final Q sample is taken (Baker, 2013; Brown, 1993; Watts & Stenner, 2012). The nature of the concourse is defined by the research questions. Stephenson viewed the concourse as a universe of shared knowledge derived from a collection of statements about any topic of interest

(Watts & Stenner, 2012), although the concourse could be developed using statements taken from an exhaustive examination of literature on the topic, photographs, artwork, and even music (Baker, 2013; Brown, 1993, p. 95). This study engaged in a dialogic discourse through a survey and an examination of scholarly work to build a concourse encompassing PreK-12 technology leader perspectives on BYOD. The dialogic nature of the researcher-participant discourse and depth of research into BYOD resulted in an authentic universe of statements regarding BYOD from which the Q sample was developed.

Q Sample

A Q sample is a group of statements taken from the ones collected during the concourse process and they represent the full range of opinion present in the raw concourse data (Brown, 1993, p.98). The statements collected during the concourse were evaluated and narrowed down to a representative sample of positive, neutral, and negative statements regarding BYOD. Watts and Stenner (2012) recommend, as a rule of thumb, that the Q sample contain between 40-80 statements (p. 61). However, a Q sample with statements numbering between 30-50 is sufficient to provide comprehensive coverage of a topic without making the sorting process too difficult or time consuming. An initially large Q sample may also be reduced through the use of piloting (Watts & Stenner, 2012). The present study used an online survey to pilot 35 statements regarding BYOD acquired through a review of the literature on BYOD. Piloting, along with open-ended response-type questions, was used to identify a concise set of statements that represent PreK-12 technology leader perceptions and that could be efficiently sorted along a continuum from most agree to most disagree. This study used 34 statements identified through the piloted statements, and, from the open-ended statements provided by the online survey. This number of statements was chosen in an effort to keep the Q-sort both comprehensive and efficient. The Q sample statements were numbered randomly and printed onto a note card in preparation for the Q-sort.

The following are the 34 Q sample statements presented to the study participants in the form of a Q-sort.

Neutral Q sample statements used in assessing participant perceptions of BYOD:

1. Environments where every student has a device allow for increased student choice.

2. Environments where every student has a device allow for improved differentiation.

3. Environments where every student has a device allow for enhanced collaboration.

4. Environments where every student has a device allow expanded assessment methods.

5. The variety of devices that students bring in allows for discussions about multiple platforms of technology.

6. The increase in access to technology is key for students.

7. All technologies used in the classroom aid in developing a more student-centered learning environment

8. It's much better for the school to provide consistent, reliable devices for every student.

9. Students will often forget to charge their devices.

10. Teachers will have to interact with different devices.

Positive Q sample statements used in assessing participant perceptions of BYOD:

1. With BYOD, students can use devices they have setup to their liking.

2. With BYOD, students can use devices with which they are familiar.

3. BYOD could get technology into students' hands in your classroom if you currently don't have it.

4. BYOD provides possible cost savings.

5. BYOD allows students to bring their technology to their learning, rather than having to adapt to the technology provided by the school.

6. BYOD allows students to have opportunities to use multiple devices and navigate seamlessly between them.

7. With BYOD, students can customize and use a device they have with them always.

8. A student’s BYOD device is potentially a better device than what the school can supply.

9. BYOD allows students the opportunity to leverage down time between classes.

10. BYOD gives the students unlimited access to information and resources.

11. BYOD allows instruction to become more student-centered.

12. BYOD allows teachers to be more connected with students and parents than ever before.

Negative Q sample statements used in assessing participant perceptions of BYOD:

1. I don't believe there is a benefit to BYOD.

2. I am not for BYOD.

3. BYOD puts your network in danger from all the malware that student devices may have on them.

4. BYOD devices will not support the higher end applications we have in place.

5. The mix of BYOD devices in the classroom may conflict with the needs of the classroom.

6. Excess bandwidth is due to all the non-academic applications on their computers.

7. BYOD results in so many random issues that a classroom cannot support.

8. BYOD increases the perceived social pressure of the "haves vs. have-nots".

9. BYOD provides an opportunity for hacking.

10. BYOD will increase cheating.

11. BYOD creates problems for teachers trying to get their instructions to work with different devices.

12. Not all students can provide a BYOD device.

Q-Sort

The researcher presented the participants with the randomly numbered Q sample statements and asked them to rank them from most agree, at one end of a continuum, to most disagree, at the other, with the neutral statements falling in the middle (Brown, 1993; Watts & Stenner, 2012). The participants were instructed to first sort the Q sample statements into three piles, one each for statements viewed as positive, neutral, and negative. A rating scale of + 4 to -4 was used in this study due to the number of sample statements used (Brown, 1993). To assist in the sorting, the participants were provided with a suggested distribution resembling a flat bell curve, where the majority of sample statements are located in the middle (neutral) with the most extreme statements on either end. The shape of the suggested distribution is superficial and has no effect on the outcome of the research and it may be altered as-needed to assist the sorter (Brown, 1993, p. 104). In this study no alterations of the suggested distribution were deemed necessary. The participant was asked to place the sorted statements on the distribution matrix according to their subjective perception of each sample statement. As a result, each statement received a numerical rating that was used for analysis. "In Q methodology, the meaning and significance of items is determined by the subject, so that the observer acquires knowledge of their meaning *a posteriori*, i.e., after the subject has sorted them" (Brown, 1980, p. 191). The *a posteriori* nature of the Q-sort provides a unique aspect to a Q methodology study. Participant responses are more likely to be authentic because participants are unable to interpret for themselves what their sort says about their perceptions of the topic of interest. The researcher revealed the significance of their sort after the fact.

Validity and Reliability

Validity in R methodology is established if it can be determined that the test conducted actually measures what it claims to measure (Field, 2015, p.12; Watts & Stenner, 2012). Reliability in R methodology is the ability of a test to produce consistent results when the same population is measured under different conditions (Field, 2015, p. 12). Brown (1980) contended that the notion of validity has no place in Q methodology because there are no external criteria that can be applied to a person's subjective point of view (p. 4). Likewise, conducting the same Q-sort repeatedly with a single participant tells more about the reliability of the participant's views than it does about the reliability of Q methodology (Watts & Stenner, 2012, p.51). This does not mean that Q methodology is not valid; it is designed to measure participant view points on a specific topic of interest. Through the use of Q-sorts, Q methodology measures what it claims to measure (Watts & Stenner, 2012). Validity in Q methodology is enhanced by researcher techniques such as discussing with and questioning participants, checking for understanding, asking for clarification, querying of specifics, or asking for elaboration of ideas in an effort to acquire complete responses used to inform the research findings. The depth of understanding of each participant's view point is used by the researcher to inform a single perspective on the topic of interest (Watts & Stenner, 2012). The connection between the research interpretation and the individual participant viewpoints is evidence that Q methodology measures what it claims to measure – people's views (Watts & Stenner, 2012, p.52).

Summary

Q methodology is a standardized approach to research used to examine the views, beliefs, values, and perspectives of people (Baker, 2013; Brown, 1980; Watts & Stenner, 2012). As such, it is a valid method for measuring the research questions engaged by the current study. This study sought to measure participant perceptions regarding the value of BYOD in the PreK-12 education setting.

The Q sample statements used in the Q-sort were crafted from an extensive review of scholarly work regarding BYOD and responses on the survey administered to participants. As a representation of all the examined viewpoints on BYOD in PreK-12 settings, these statements were sorted by the study participants and subsequently interpreted by the researcher.

The current study was developed to add to the existing knowledge regarding BYOD programs by examining the perceptions of PreK-12 technology leaders regarding such programs. Understanding participant perceptions could assist PreK-12 school leaders in determining the extent their technology leader perspectives of BYOD programs might impact the decisions made that directly contribute to the success or failure of that program. This knowledge can allow schools to manage the impact those beliefs might have on their BYOD initiative. The subsequent chapter presents the research findings based on an analysis of the data collected.

Chapter 4

Analysis of Data

This chapter presents the analysis of the data collected in the current study. The analyzed data were collected in the form of Q-sorts conducted with 13 PreK-12 technology leader participants working either in Ohio or Pennsylvania. As Q methodology is a mixed methods approach to research, the data collection processes used by the current study reflect a mix of methods. The quantitative data disclosed by each participant sort were recorded using a standardized form (Appendix A) manually completed by the researcher and a photograph of each participant's Q-sort was taken as a validation tool, if an error occurred in the manual recording. The qualitative data were collected in the form of audio recordings of each Q-sort session and were subsequently transcribed and used to inform the results discussed later in this chapter. The standardized form data, photographs, recordings, and transcriptions provide authentic evidence of each participant's viewpoint regarding BYOD as examined by the 34 statements sorted and discussed during each Q-sort session.

Software specifically designed for use in analyzing Q methodology data, PQMethod 2.35 for Windows, was used to perform the statistical analysis. PQMethod software for Windows was adapted from its original FORTRAN-77 mainframe programming language under the guidance of Steven Brown (1993) and is maintained by Peter Schmolck (Schmolck, 2014). This free-to-use statistical software package provides the ability to enter Q-sort data, conduct a factor analysis of the data using the Principal

Component Analysis method, and produce the comprehensive set of statistics used to describe the data presented in this chapter.

Correlation Matrix

Correlation is a statistical measure of the "strength of relationship between two variables" (Shadish, Cook, & Campbell, 2002, p. 506) "In Q methodology correlation provides a measure of the nature and extent of the relationship between any two Q sorts and hence a measure of their similarity or otherwise" (Watts & Stenner, 2012, p. 97). The correlation matrix presented in this chapter is a graphic representation of the correlation between each Q-sort with every other sort. This matrix serves as a simple measure of association between participant viewpoints and these correlation statistics provide a measure by which to determine the level to which participants agree or disagree with each other (Watts & Stenner, 2012, p. 8). Correlations are scored on a continuum from +1 to -1. The relationship between variables (participant views), as communicated by each score, reveals one of three possible relationships (Field, 2015):

- A positive score is indicative of a positive relationship;
- A score of zero indicates no relationship at all; and
- A negative score is indicative of a negative relationship.

The degree to which the participant views are associated can be interpreted by using a standard measure of observed effect size. Correlation values of ±.1 represent a small association, ±.3 represent a medium association, and ±.5 represent a large association (Field, 2015, p. 267). The resulting values indicate both the magnitude (size) and the direction of the relationship. Positive values indicate a positive relationship. Negative values indicate a negative relationship.

The 13 individual sorts were assigned a unique code located in the left most column of Table 1. Each participant code began with an ordinal number indicating the sequence in which that Q-sort was conducted. The level of correlational significance in Q methodology is determined using the statistical equation $2.58 \times (1/\sqrt{N})$ where N represents the number of statements in the Q-sort (Watts & Stenner, 2012, p. 202). Consequently, to be statistically significant in this study, a correlation must be ±.44 (calculated as $2.58 \times (1/\sqrt{34}) = 0.44$). Table 1 provides the correlation matrix of the 13 sorts, with significant correlations indicated in bold type.

Table 1.

Correlation Matrix Between Sorts

Sorts	1	2	3	4	5	6	7	8	9	10	11	12	13
01FS39	1.00	0.42	0.16	0.03	-0.06	**0.50**	0.20	-0.19	0.21	0.18	**0.56**	-0.02	-0.05
02MS11		1.00	**0.51**	0.27	0.25	**0.52**	0.17	-0.01	0.31	0.08	**0.61**	0.19	0.25
03MU49			1.00	0.37	0.28	**0.56**	0.07	-0.09	**0.46**	0.21	0.41	0.19	0.26
04FS15				1.00	0.16	0.20	0.21	0.24	0.12	-0.16	0.22	0.29	0.25
05MS10					1.00	0.31	0.10	**0.61**	0.39	0.18	0.16	-0.03	0.24
06MS49						1.00	0.40	0.11	**0.47**	0.12	**0.46**	0.11	0.31
07MS12							1.00	0.18	0.12	0.32	0.33	**0.44**	0.18
08MS07								1.00	0.13	-0.04	-0.01	0.08	0.30
09MR48									1.00	0.18	0.33	0.36	**0.61**
10FR39										1.00	0.00	0.27	0.26
11MS21											1.00	0.29	0.09
12FT34												1.00	0.26
13MT47													1.00

Note. Bold values are significant at the $\alpha < .01$ level

The results present in Table 1 show many moderate-to-high correlations between participant viewpoints, as indicated by values of .44 or higher ($r \geq .44$). While the matrix does include a number of small and negative associations ($r < .44$), the results show no significant negative associations between participant viewpoints ($r \leq -.44$). Continued analysis of the data, through the identification of common variance, reveals the shared meaning in the variables as a set of factors. The factors identified represent the commonalities present in the study's participant views of BYOD.

A set of factors was extracted using Principal Component Analysis (PCA), which is a statistical technique used to identify a set of variables or factors (Field, 2015). PCA aims to "account for all variance, therefore minimizing the error variance in the analysis" (K. H. Larwin, personal communication, March, 16, 2019). PCA calculations were conducted on the unrotated columns of the factor matrix. PQMethod 2.35 for Windows presents PCA results in the form of eigenvalues, which is a sum for all the squared loadings of all the Q-sorts on a particular factor (Watts & Stenner, 2012, p. 105). PCA results were used to calculate variance and each factor's statistical strength. PCA results are shown in Table 2 with eigenvalues ranging from 4.009 for factor 1 to .551 for factor 8.

Table 2.
Eigenvalues

Factors	1	2	3	4	5	6	7	8
Eigenvalues	**4.009**	**1.9127**	**1.4138**	1.2388	1.1302	0.7808	0.6693	0.551
% of Expl. Var.	31	15	11	10	9	6	5	4

The eigenvalues in bold type belong to the factors determined to be most likely to provide meaningful factor analysis. It was determined, through careful consideration of the extracted eigenvalues, that factors 1, 2, and 3 should be the ones examined closely as they represent 57% of the study variance. Watts and Stenner (2012) indicated that an eigenvalue of 1.00 is the typical cut-off for determining how many factors are extracted for continued data analysis (p. 105). A value of 1.00 indicates the amount of study variance represented by a single Q-sort, a value of < 1.00 represents less study variance than a single sort, and an eigenvalue > 1.00 represents the study variance represented by multiple Q-sorts (Watts & Stenner, 2012). The eigenvalues for factors 4 and 5 were determined to be close enough to the cut-off score (1.00) as to not add import to the current study. With 13 sorts, it is important to maintain parsimony with good reliability. Adding additional factors to the model would violate the parsimony of this model and could result in multiple factors represented by a single sort. A model with multiple factors represented by one sort does not support the parsimony or stability of the model. Therefore, a three-factor model is the best model for explaining participant viewpoints of BYOD.

Q methodology measures the subjective viewpoints of participants on the topic of interest (Brown, 1993). Viewpoints or perceptions in Q methodology become the unit of measure. As a result, the data from each participant sort are treated as a unique variable (Brown, 1993).

Table 3 depicts the degree to which each variable (participant viewpoint as captured by each Q-sort) is associated with each factor in the three-factor model. The x and bold type indicate the defining sorts for each factor.

Table 3.

Factor Matrix with an x Indicating a Defining Sort

Factor	1	2	3
Sort			
01FS39	.4600	**-.06465x**	-.02670
02MS11	**.7078x**	-.02978	-.02456
03MU49	**.6866x**	-.1089	-.2074
04FS15	**.4350x**	.1932	-.1769
05MS10	.4626	.5539	-.3571
06MS49	**.7722x**	-.1751	-.1551
07MS12	.4840	.0294	**.5465x**
08MS07	.2236	**.7473x**	-.2026
09MR48	**.6956x**	.2076	.0029
10FR39	.3050	.0691	**.6232x**
11MS21	**.6833x**	-.4160	-.0979
12FT34	.4527	.1347	**.6104x**
13MT47	**.5409x**	.4701	.1288

Table 3 demonstrates that the selected three-factor model represents 12 of 13 participant viewpoints with zero variables loading into more than one factor. One participant sort, 05MS10, failed to load into any of the 3 factors. Consequently, sort 05MS10 is considered an outlier. One participant sort, 01FS39, loaded with a negative value. This negative value combined with the other positively loaded significant sort for Factor 2 indicates that Factor 2 is binary.

Q-Sort Statements with Corresponding Ranks

Z-scores are used to determine the extent to which each factor agrees with each statement used in the study. A Z-score is “the value of an observation expressed in standard deviation units” (Field, 2015, p. 886). The standardization of variables using Z-scores allows for direct comparisons across factors (Schmolck, 2014). Z-scores reveal the level of agreement or disagreement for the statements used in the study in relation to each factor in the three-factor model. A Z-score represented by a positive number indicates agreement with the statement by the Q-sort participant for each factor. Conversely, a Z-score represented by a negative number indicates disagreement with the statement by the Q-sort participant.

Table 4 provides the Z-scores, in rank order from most agree to least agree for Factor 1, the Integrationists. Only statements with Z-scores $> +1.00$ and < -1.00 have been included in the table.

Table 4.

Ranked Z scores for Factor 1

No.	Statement	Z-score
6	Environments where every student has a device allows expanded assessment methods.	1.810
22	Environments where every student has a device allows for improved differentiation.	1.729
23	Environments where every student has a device allows for enhanced collaboration.	1.690
26	The increase in access to technology is key for students.	1.326
31	Environments where every student has a device allow for increased student choice and agency.	1.187
9	It's much better for the school to provide consistent, reliable devices for every student.	1.175
2	Excess bandwidth is due to all the non-academic applications on their computers.	-1.017
20	Students have the opportunity to see how a variety of devices work.	-1.035
11	Students will often forget to charge their devices.	-1.125
4	BYOD devices will not support the higher end applications we have in place.	-1.337
10	BYOD will increase cheating.	-1.361
1	I am not for BYOD.	-1.392
12	I don't believe there is a benefit to BYOD.	-1.771

Note. Table contains only the statements with Z-scores >+1.00 and <-1.00

Tables 5 and 6 display similar results for Factors 2 and 3, respectively. Complete Z-score statistics for all statements and factors are included in Appendix B.

Table 5 provides the Z-scores, in rank order from most agree to least agree for Factor 2, the Regulators. Only statements with Z-scores > +1.00 and <-1.00 have been included in the table.

Table 5.

Ranked Z-scores for Factor 2

No.	Statement	Z-score
11	Students will often forget to charge their devices.	1.633
2	Excess bandwidth is due to all the non-academic applications on their computers.	1.512
25	BYOD puts your network in danger from all the malware that student devices may have on them.	1.512
8	BYOD creates problems for teachers trying to get their instructions to work with different devices.	1.282
18	BYOD could get technology into students' hands if you currently don't have it.	1.173
21	BYOD provides an opportunity for hacking.	1.162
17	With BYOD, students can use devices they have setup to their liking.	-1.052
4	BYOD devices will not support the higher end applications we have in place.	-1.173
16	BYOD allows instruction to become more student-centered.	-1.271
3	BYOD allows students to have opportunities to use devices and navigate seamlessly between them.	-1.392
28	BYOD allows students to bring their technology to their learning, rather than having to adapt to the technology provided by the school.	-1.392
33	BYOD gives the students unlimited access to information and resources.	-1.512
13	BYOD allows teachers to be more connected with students and parents than ever before.	-1.633

Note. Table contains only the statements with Z-scores >+1.00 and <-1.00

Table 6 provides the Z-scores, in rank order from most agree to least agree for Factor 3, the Pragmatists. Only statements with Z-scores > +1.00 and <-1.00 have been included in the table.

Table 6.

Ranked Z-scores for Factor 3

No.	Statement	Z-score
34	Not all students can provide a BYOD device.	2.203
33	BYOD gives the students unlimited access to information and resources.	1.702
5	With BYOD, students can use devices with which they are familiar.	1.597
29	The mix of BYOD devices in the classroom may conflict with the needs of the classroom.	1.446
30	BYOD increases the perceived social pressure of the "haves vs. have-nots".	1.298
9	It's much better for the school to provide consistent, reliable devices for every student.	1.128
8	BYOD creates problems for teachers trying to get their instructions to work with different devices.	1.033
25	BYOD puts your network in danger from all the malware that student devices may have on them.	-1.00
27	BYOD provides possible cost savings.	-1.020
3	BYOD allows students to have opportunities to use devices and navigate seamlessly between them.	-1.043
1	I am not for BYOD.	-1.321
12	I don't believe there is a benefit to BYOD.	-1.364
10	BYOD will increase cheating.	-1.617

Note. Table contains only the statements with Z-scores >+1.00 and <-1.00

Factor Arrays

A factor array in Q methodology is a Q-sort configured to represent the collective views of a particular factor (Watts & Stenner, 2012, p. 140). A factor array is a visual representation of the factor's communal view point complying to the same distribution used in data collection (Watts & Stenner, 2012). To construct the array the researcher uses the rank ordered Z-scores for each factor to determine each statement's place in the array. The statements are placed into the distribution on a continuum with highest positively ranked Z-scores going in the agree most column, while the statements with the lowest Z-scores are located in the disagree most column. According to Watts and Stenner (2012), a factor array provides “the best possible estimate of the relevant factor and in so doing to get a sense of what its 100% or perfectly loading Q sort might actually look like” (p. 141).

Figures 1-3 are the factor arrays for each of the three factors.

Disagree Most								Agree Most
-4	-3	-2	-1	0	1	2	3	4
1	11	29	25	17	18	9	23	6
12	4	3	8	19	34	27	26	22
	10	2	7	28	14	32	31	
		20	21	33	16	30		
			13	15	5			
				24				

Figure 1. Model Array for Factor 1 (Integrationists)

Variance = 4.706 and St. Dev. = 2.169

Disagree Most								Agree Most
-4	-3	-2	-1	0	1	2	3	4
33	16	19	10	7	34	21	25	11
13	3	6	22	14	27	30	8	2
	28	17	26	24	9	1	18	
		4	23	5	29	32		
			20	15	12			
				31				

Figure 2. Model Array for Factor 2 (Regulators+)

Variance = 4.706 and St. Dev. = 2.169

Disagree Most								Agree Most
-4	-3	-2	-1	0	1	2	3	4
12	27	26	20	17	7	9	5	34
10	3	18	14	13	24	8	29	33
	1	4	16	32	31	19	30	
		25	2	6	23	15		
			11	21	22			
				28				

Figure 3. Model Array for Factor 3 (Pragmatists)

Variance = 4.706 and St. Dev. = 2.169

Factor Interpretation: Similarities and Differences Between the Factors

A number of data points must be examined in order to fully understand the viewpoints revealed in the Q-sort process (Watts & Stenner, 2012). This chapter has examined the correlation between variables to determine if shared points of view exist and how strongly they exist using the correlation matrix (Table 1). Subsequently, eigenvalues (Table 2) and a factor matrix (Table 3) were used to identify a three-factor model representing 57% of the study's variance. In addition, Z-scores were used to identify the extent to which participant views regarding the 34 Q-sort statements agreed or disagreed with the three factors in the model (Tables 4-6) and factor arrays have been presented as a depiction of what a 100% loading Q-sort might look like for each factor (Figures 1-3). Each of these processes, along with the ones to follow, are designed to help in either the identification or the interpretation of each of the factors.

Table 7 assists in interpretation by providing a correlation analysis that examines the relationships between the factors.

Table 7.

Correlation Between Factors

Factors	1	2	3
1	1.00	-0.02	0.35*
2		1.00	-0.01
3			1.00

Note. Asterisk (*) indicates significance at $p<.05$ level.

As previously discussed, correlations are measured on a continuum from +1 to -1 and the degree to which the factors are associated can be interpreted by using a standard measure of observed effect size. Correlation values of ±.1 represent a small association, ±.3 represent a medium association, and ±.5 represent a large association (Field, 2015, p. 267). Table 7 reveals that negative correlations exist between factors 1 and 2, also between factors 2 and 3. This provides evidence of good discriminant validity. Table 7 also indicates that factors 1 and 3 have a moderate correlation. Since already having determined that no single participant loads into more than one factor (Table 3), the moderate correlation between factors 1 and 3 indicates that specific statements loaded similarly for each of those factors. This similar loading can be observed in Figures 1 and 3 where the model arrays reveal that statements 12 and 9 loaded in identical columns, with statement 12 (*"I don't believe there is a benefit to BYOD"*) loading as a -4 for both factors. This loading indicates that both factor 1 and 3 participants have a strongly held negative view of statement 12.

Before more in-depth interpretation is considered, it is important to establish that the data supporting factor analysis are reliable. In the previous chapter it was established that reliability in Q methodology is different than reliability measures in R methodology, in which reliability is the ability of a test to produce consistent results when the same population is measured under different conditions (Field, 2015, p. 12). In Q methodology, conducting the same Q-sort repeatedly with a single participant tells more about the reliability of the participant's views than it does about the reliability of Q methodology (Watts & Stenner, 2012, p. 51). Brown (1980) contended that what is needed to establish reliability in Q methodology is a composite reliability measure of all the sorts at a given point in time with all of those at a different point in time when all participants define the same factor (p.289). The composite reliability measure in Table 8 is "provided by Spearman's formula for the correlation of sums or differences" (Brown, 1980, p. 290) as calculated using PQMethod 2.35 for Windows.

Table 8 shows the Q methodology reliability statistics for the three factors under investigation in the current study.

Table 8.

Factor Reliability Characteristics

	Factors		
	1	**2**	**3**
No. of Defining Variables	7	2	3
Average Rel. Coef.	0.800	0.800	0.800
Composite Reliability	0.966	0.899	0.923
S.E. of Factor Z-scores	0.186	0.333	0.277

Table 8 indicates that the data for the 12 variables (participant viewpoints) grouped together as unique factors have good reliability as expressed by composite reliability scores and good standard error measurements as expressed by S.E. of factor Z-scores. A perfect composite reliability score would be 1.00 (Brown, 1980). Table 8 demonstrates that the three factors in in the current study have composite reliability scores close to 1.00.

Factor Analysis: Understanding Participant Viewpoints

This section will provide a description of each of the three factors including a descriptive name, summary and demographic details of the participants who loaded for each factor. The names assigned to each factor, created by the researcher, are intended to represent the distinguishing characteristics of each factor. Additional factor details include distinguishing statements for each factor; distinguishing statements provide evidence of the similarities and differences between two or more factors (Herrington & Coogan, 2011, p. 27). The distinguishing statements are used to define the overall viewpoint expressed by each factor and its underlying participants. Tables 9, 10, and 12 identify statements that each factor ranked higher or lower when compared to the other two factors. A difference at the $p < 0.01$ level is represented with an asterisk (*).

Factor 1: Integrationists

Table 9.

Distinguishing Statements for Factor 1

Factor		1		2		3	
No.	Statement	Q-SV	Z-SC	Q-SV	Z-SC	Q-SV	Z-SC
6	Environments where every student has a device allows expanded assessment methods.	4	1.81*	-2	-0.93	0	-0.22
22	Environments where every student has a device allows for improved differentiation.	4	1.73*	-1	-0.46	1	0.23
23	Environments where every student has a device allows for enhanced collaboration.	3	1.69*	-1	-0.81	1	0.27
26	The increase in access to technology is key for students.	3	1.33*	-1	-0.57	-2	-0.82
31	Environments where every student has a device allow for increased student choice and agency.	3	1.19	0	-034	1	0.39
16	BYOD allows instruction to become more student-centered.	1	0.43*	-3	-1.27	-1	-0.55
19	Student familiarity with her/his own device is important.	0	0.27	-2	-0.93	2	0.94
33	BYOD gives the students unlimited access to information and resources.	0	-0.05*	-4	-1.51	4	1.70
8	BYOD creates problems for teachers trying to get their instructions to work with different devices.	-1	-0.56*	3	1.28	2	1.03
7	Teachers will have to interact with different devices.	-1	-0.66*	0	0.35	1	0.77
29	The mix of BYOD devices in the classroom may conflict with the needs of the classroom.	-2	-0.72*	1	0.58	3	1.45

Note. Asterisk (*) indicates significance at p < .01.

Table 9 provides the Q-SV and Z-SC for the distinguishing statements defining Factor 1 (Integrationists) for comparison with Factors 2 (Regulators) and 3 (Pragmatists). It is clear from the data provided that PreK-12 technology leader viewpoints represented by the distinguishing statements for Factor 1 are distinct from those of the PreK-12 technology leader viewpoints captured by Factors 2 and 3.

Factor 1 was identified as contributing to meaningful analysis in this study because it had an eigenvalue of 4.009 and explains 31% of the study variance (Table 2). In addition, Factor 1 contains 7 significantly loaded participant sorts (Table 3). The data supporting Factor 1 is considered to have good reliably and a good measure of standard error (Table 8).

Participant demographics for Factor 1 include gender, school district typology, and the percentage of student poverty in the district represented. District typology and student poverty percentages for Factor 1 and for all of the factors analyzed in the current study were determined using the State of Ohio's 2013 typology criteria and the data contained in the published list of each Ohio school district and its assigned typology on the Ohio Department of Education (ODE) typology website (Typology of Ohio School Districts, 2015). Data from Pennsylvania participants were interpreted to accurately reflect an Ohio typology. Pennsylvania data, for all factors, were acquired from the Pennsylvania Department of Education (PDE) website containing national school lunch program data (National School Lunch Program Reports, 2018).

Factor 1 (Integrationists) demographic data are comprised of the following:

- 6 male and 1 female participant loaded significantly for Factor 1;
- 4 suburban, 1 urban, 1 rural, and 1 town districts;
- 4 school districts had a student poverty percentage in the range of 47%-49%; and
- 3 school districts had a student poverty percentage in the range of 11%-21%

Eighty-six percent of the participant sorts captured by Factor 1 were conducted by males and 14% conducted by a female participant. Factor 1 is predominately male. Fifty-eight percent of Factor 1 participants work in a suburban school district with 14% of the participants belonging to urban-, rural- and town-designated districts. Factor 1 is predominately represented by suburban districts. The participant sorts supporting Factor 1 represent a wide range of student poverty between 11% - 49%. A synopsis of the Factor 1 (Integrationist) viewpoint follows. Rankings of relevant statements are provided. For example, a ranking of (6:+4) indicates that statement 6 was ranked with a +4 Q-sort value. Participant comments that clarify and support interpretation are cited and indicated by italic type.

The Integrationist Viewpoint

The Integrationists placed a high value on statements reflecting a positive role for technology in teaching and learning. Statements such as, environments where every student has a device allows expanded assessment methods (6: +4), environments where every student has a device allows for improved differentiation (22: +4), environments where every student has a device allows for enhanced collaboration (23: +3), the increase in access to technology is key for students (26: +3), and environments where every student has a device allow for increased student choice and agency (31:+3) reflect a positive view of technology in the classroom that is not specific to BYOD. Participant 13MT47 confirmed this interpretation best,

> *I think that by putting it up far to the right, I want to show that I definitely support that 1-to-1 model, where we have pervasive computers in the hands of students. .I think it's really important to put that into perspective, even though I seem to you know have some negative opinions of BYOD, its-- I have a very high opinion of*

every student with a device. And I totally agree with collaboration, differentiation, and assessment models

Participant 02MS11 explained further,

environments where every student has a device allows for improved differentiation and BYOD allows instruction to be more student-centered. When I look at when we chose to move to a model where every student has a device, those were the reasons we did that. Number 1 was differentiation…

In referring to statement 26, the increase in access to technology is key for student (26: +3), participant 06MS49 explained the placement of that statement as a +4 by stating,

…I think that any tool we can get on the internet and provide access is a key for students. That's where our future is. In fact, I'd say more of our concern is when they can't have access to any form of technology at the home, is one of our bigger issue concerns…

The qualitative data for the Integrationists supported a shared viewpoint that technology plays a positive role in teaching and learning and the value of technology in learning is not specifically connected to BYOD but with technology as a whole.

Accordingly, the Integrationists devalued the perception that BYOD devices will create problems for teachers and instruction. Integrationists placed a high instructional value on technology in all its forms. Integrationists disagreed with statements such as, BYOD creates problems for teachers trying to get their instructions to work with different devices (8: -1), teachers will have to interact with different devices (7: -1), and the mix of BYOD devices in the classroom may conflict with the needs of the classroom (29: -2).

Participant 03MU49, expresses the view that the type device is secondary to its instructional value:

> *…it should be the instruction that drives what we're doing, and not the device its—it shouldn't, yeah—we should find the instruction first, and then worry about the device, rather than worry about the 15 or 20 different devices and then go back and go 'okay, what can we find that fits?*

In summary, the Integrationists are predominately male, PreK-12, technology leaders working in suburban districts with wide range of student poverty. An Integrationist believes that technology in all its forms plays a positive role in teaching and learning. The Integrationist view partners technology with instruction in a way that amplifies the importance of pedagogy over the type of device.

Factor 2: The Regulators+

Factor two is considered a binary or bipolar factor as it is defined by both positive and negative loading Q-sorts (Watts & Stenner, 2012). When this occurs, two interpretations are conducted representing each of the opposing viewpoints (Watts & Stenner, 201). The bulk of this section will be interpreted from the perspective represented by the significantly loaded participant sort 08MS07. This positively loading sort most clearly explains the Regulators'+ viewpoint using the data expressed in Table 10. The opposing negatively loading view point, Regulators-, also contributing significantly to the shared viewpoint of the Regulators± will be explained and presented in a subsequent section.

The distinguishing statements in Table 10 are used to define the overall viewpoint expressed by Factor 2 (Regulators±). Table 10 identifies statements that Factor 2 ranked higher or lower when compared to the other two factors. A difference at the $p < 0.01$ level is represented with an asterisk (*).

Table 10.

Distinguishing Statements for Factor 2

Factor		1		2		3	
No.	Statement	Q-SV	Z-SC	Q-SV	Z-SC	Q-SV	Z-SC
11	Students will often forget to charge their devices.	-3	-1.13	4	1.63*	-1	-0.80
2	Excess bandwidth is due to all the non-academic applications on their computers.	-2	-1.02	3	1.51*	-1	-0.71
25	BYOD puts your network in danger from all the malware that student devices may have on them.	-1	-0.51	3	1.51*	-2	-1.00
21	BYOD provides an opportunity for hacking.	-1	-0.71	2	1.16*	0	-0.24
1	I am not for BYOD.	-4	-1.39	2	0.92*	-3	-1.32
29	The mix of BYOD devices in the classroom may conflict with the needs of the classroom.	-2	-0.72	1	0.58	3	1.45
12	I don't believe there is a benefit to BYOD.	-4	-1.77	1	0.57*	-4	-1.36
10	BYOD will increase cheating.	-3	-1.36	-1	-0.36*	-4	-1.62
23	Environments where every student has a device allows for enhanced collaboration.	3	1.69	-1	-0.81	1	0.27
19	Student familiarity with her/his own device is important.	0	0.27	-2	-0.93*	2	0.94
17	With BYOD, students can use devices they have setup to their liking.	0	0.28	-2	-1.05	0	-0.10
28	BYOD allows students to bring their technology to their learning, rather than having to adapt to the technology provided by the school.	0	-0.05	-3	-1.39	0	-0.43
33	BYOD gives the students unlimited access to information and resources.	0	-0.05	-4	-1.51*	4	1.70
13	BYOD allows teachers to be more connected with students and parents than ever before.	-1	-0.72	-4	-1.63	0	-0.14

Note. Asterisk (*) indicates significance at p < .01.

Table 10 provides the Q-SV and Z-SC for the distinguishing statements defining Factor 2 (Regulators±) for comparison with Factors 1 (Integrationists) and 3 (Pragmatists). It is clear from the data provided that PreK-12 technology leader viewpoints represented by the distinguishing statements for Factor 2 are distinct from those of the PreK-12 technology leader viewpoints captured by Factors 1 and 3.

Factor 2 was identified as contributing to meaningful analysis in this study because it had an eigenvalue of 1.9127 and explains 15% of the study variance (Table 2). In addition, Factor 2 contains two significantly loaded participant sorts (Table 3). The data supporting Factor 2 are considered to have good reliably and a good measure of standard error (Table 8).

Participant demographics for Factor 2 included gender, school district typology, and the percentage of student poverty in the district represented. Factor 2 (Regulators±) demographic data are comprised of the following:

- 1 male and 1 female participant loaded significantly for Factor 2;
- 2 suburban districts are represented in Factor 2;
- 1 school district has a student poverty of 39%; and
- 1 school district has a student poverty of 7%

Fifty-percent of the participant sorts captured by Factor 2 were conducted by a male and 50% were conducted by a female participant. Factor 2 was equally represented by both genders. One hundred-percent of Factor 2 participants worked in a suburban school district. The significantly loaded participant sorts supporting Factor 2 represented student poverty at distinctly different levels, a gap of 32% student poverty separates the two districts. A synopsis of the positively loaded Factor 2 (Regulators+) viewpoint follows. Rankings of relevant statements are provided. For example, a ranking of (6: +4) indicates that statement 6 was ranked with a +4 Q-sort value. Participant comments used to clarify and support the interpretation are cited and indicated by italic type.

The Regulators'+ Viewpoint

The Regulators+ place value in statements reflecting a concern about BYOD and the potential problems it introduces to the school environment. Statements such as students will often forget to charge their devices (11: +4), excess bandwidth is due to all the non-academic applications on their computers (2: +3), BYOD puts your network in danger from all the malware that student devices may have on them (25: +3) indicate concerns about problems associated with BYOD. In addition, statements such as BYOD provides an opportunity for hacking (21: +2) and I don't believe there is a benefit to BYOD (12: +1) reflect a negative view of BYOD held by Regulators+. The following is an excerpt from the dialogue recorded during participant 08MS07's Q-sort; describing why statement 11 was placed in the agree most column 08MS07stated:

08MS07: *I think that would be a huge issue.*

Researcher: *Okay. They're not going to remember to charge?*

08MS07: *Yeah, or they're going to come and it's going to die after an hour and you know, we'll be providing charging stations for devices.*

The same participant explained bandwidth concerns (2: +3), with the following exchange:

08MS07: *We shut down their devices, and we measure our bandwidth at the time, man it doubles, it's uh-- they're big hogs.*

Researcher: *And do you shut it down during testing?*

08MS07: *Yeah. We certainly do. And uh our train of thought is changing a little bit, which is good. Because I never agreed with this, but part of us doing wireless was to give the students and their parents a way to get on wireless and not use their own data for-- like an airport--*

Researcher: *Or a hotel?*

08MS07: *Yeah. And I just think that thought process is ridiculous. We're spending money to make it convenient. You know what I mean?...*

The same participant explained both hacking and malware concerns (25: +3, 21: +2), with the following exchange:

Researcher: *...And then the last 1 in column 8 is 'BYOD puts your network in danger from all the stuff on student devices'*

08MS07: *Well I think that goes along with the opportunity for hacking. I'm not so concerned about the malware, but I am concerned about high school students being able to do things without being seen. You know what I mean, if they have their own device, they can get away with doing a lot more than if the Chromebook is sitting on their desk. So I would-- I'm concerned about that. We got some very smart kids…*

The qualitative data for the Regulators+, in particular the statements of participant 08MS07, support a shared viewpoint expressing a negative view of BYOD and the problems it introduces into the school environment.

Regulators+ do not see BYOD as contributing to an increased communication with students and parents (13: -4) or providing unlimited access to information and resources (33: -4). Participant 08MS07explained a view of the role BYOD plays in school communications (13: -4), with the following exchange:

Researcher: *Alright. On the other end of the spectrum, ones you most disagree with. BYOD allows teachers to be more connected with students and parents than ever before.*

08MS07: *In our situation, I don't know that BYOD would actually increase that. I think we're already so connected electronically with our parents and with our students. That I don't think the kids using their own device, is going to increase the communication at all.*

Researcher: *So teachers now are-- they're emailing parents to communicate? Teachers are communicating with kids obviously face to face.*

08MS07: *Face to face, Google Classroom, email, yeah.*

Researcher: *Alright. And then you probably have like School Messenger or some other alert system?*

08MS07: *Right. I just don't, I mean there's ways to increase communication. I don't think BYOD will do that. Okay?*

In summary, the Regulators± are equally male and female, PreK-12, technology leaders working in suburban districts representing a diverse level of student poverty. A

Regulator+ belief reflects a concern about BYOD and the problems it introduces to the school environment. A Regulator+ does not see BYOD as contributing to improved school-to-home communications or in providing unlimited access to information and resources.

Factor 2: Regulators-

Each participant who significantly loaded into Factor 2 contributed to the shared viewpoint of the Regulators in a different way. The views of one participant were in direct opposition to the other significantly loaded Q-sort. For Factor 2, one participant (01FS39) loaded significantly with a positive score while the other participant (08MS07) loaded with a negative score, which is called a binary or bipolar factor (Watts & Stenner, 2012, p. 165). This suggests that the viewpoint expressed by the negatively loaded Q-sort conducted with participant 01FS39, is the polar opposite of the view point expressed by the positively loaded Q-sort conducted with participant 08MS07. When this occurs the two sorts can be described as being a mirror-image of each other (Watts & Stenner, 2012, p. 165). This is because "negative factor loadings indicate a reversal of the values that positively define a factor" (McKeown & Thomas, 2013, p. 12). In this case, participant sort 01FS39 contributed significantly to the interpretation of Factor 2 precisely because it represented direct opposition to the prevailing views expressed by the other significant Regulator, participant 08MS07. When explaining a bipolar factor, Watts and Stenner (2012) recommended presenting a second interpretation representing a second view point from the opposing pole (p. 165). This section will present the Regulators- viewpoint from the opposing perspective as evidenced by sort 01FS39. This polar opposite interpretation requires that the data for Factor 2 (Regulators+) be manually "turned back to front" by the researcher (Watts & Stenner, 2012, p. 165).

Before manually inverting the existing interpretation for the Regulators, it is important to establish that the opposing viewpoint is in fact distinctly different than the prevailing positive Q-sort. Figure 4 is a factor array presented as a visual representation of the view point expressed by 01FS39 resulting from the Q-sort process.

Disagree Most								Agree Most
-4	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**
1	10	2	29	14	18	33	3	16
12	27	24	11	7	15	23	31	26
	9	25	8	17	19	22	28	
		21	4	5	6	20		
			30	32	13			
				34				

Figure 4. Q-sort of 01FS39 (Regulator-)

Figure 4 assists in the counter interpretation of Factor 2 as a contrast point to the Factor 2 model array presented in Figure 2. A direct comparison between Figure 2 and Figure 4 reveals only three similarly placed statements (14: 0, 7: 0, 5: 0). Each of the three similarly placed statements have a Q-sort value of 0 indicating that a Regulator, on either pole of the shared perspective, has a solidly neutral communal view of these three statements. In addition, the direct comparison reveals many differences between the model array for the positively loaded Factor 2 (Regulators +) as presented in Figure 2 and the Q-sort provided by 01FS39.

Table 11 presents the Q-SV for the Factor 2 model array and the 01FS93 Q-sort with similarly sorted statements removed. The Q-Sort value differences provided are absolute values calculated using the equation $\left|(\text{model Q-SV}) - (\text{01FS39 Q-SV})\right|$. Items in bold type are distinguishing statements for Factor 2 as established in Table 10.

Table 11.

Q-Sort Value Differences for Factor 2

Statement		Model Q-SV	01FS39 Q-SV	Q-SV Diff.
1	**I am not for BYOD.**	**2**	**-4**	**6**
2	**Excess bandwidth is due to all the non-academic applications on their computers.**	**4**	**-2**	**6**
3	BYOD allows students to have opportunities to use devices and navigate seamlessly between them.	-3	3	6
4	BYOD devices will not support the higher end applications we have in place.	-2	-1	1
6	Environments where every student has a device allows expanded assessment methods.	-2	1	3
8	BYOD creates problems for teachers trying to get their instructions to work with different devices.	3	-1	4
9	It's much better for the school to provide consistent, reliable devices for every student.	1	-3	4
10	**BYOD will increase cheating.**	**-1**	**-3**	2
11	**Students will often forget to charge their devices.**	**4**	**-1**	5
12	I don't believe there is a benefit to BYOD.	1	-4	5
13	**BYOD allows teachers to be more connected with students and parents than ever before.**	**-4**	**1**	5
15	A student's BYOD device is potentially a better device than what the school can supply.	0	1	1
16	BYOD allows instruction to become more student-centered.	-3	4	7
17	With BYOD, students can use devices they have setup to their liking.	-2	0	2
18	BYOD could get technology into students' hands if you currently don't have it.	3	1	2
19	**Student familiarity with her/his own device is important.**	**-2**	**1**	3

20	Students have the opportunity to see how a variety of devices work.	-1	2	3
21	**BYOD provides an opportunity for hacking.**	**2**	**-2**	4
22	Environments where every student has a device allows for improved differentiation.	-1	2	3
23	**Environments where every student has a device allows for enhanced collaboration.**	**-1**	**2**	3
24	BYOD results in so many random issues that a classroom cannot support.	0	-2	2
25	**BYOD puts your network in danger from all the malware that student devices may have on them.**	**3**	**-2**	5
26	The increase in access to technology is key for students.	-1	4	5
27	BYOD provides possible cost savings.	1	-3	4
28	BYOD allows students to bring their technology to their learning, rather than having to adapt to the technology provided by the school.	-3	3	6
29	The mix of BYOD devices in the classroom may conflict with the needs of the classroom.	1	-1	2
30	BYOD increases the perceived social pressure of the "haves vs. have-nots".	2	-1	3
31	Environments where every student has a device allow for increased student choice and agency.	0	3	3
32	BYOD allows students the opportunity to leverage down time between classes.	3	0	3
33	**BYOD gives the students unlimited access to information and resources.**	**-4**	**2**	6
34	Not all students can provide a BYOD device.	1	0	1

Note. Bold type indicates distinguishing statements with significance at $p < .01$. Differences are reported as absolute values.

Table 11 reveals the mean Q-SV difference for the distinguishing statements as $|4.5|$. This establishes that participant 01FS39 viewpoint is distinctly different than the model array for Factor 2. This marked difference contributes significantly to the interpretation of Factor 2 precisely because it represents a mirror image of the views expressed by the model array (Figure 2). and by the positively loaded Q-sort from 08MS07.

The value of a mixed methods approach to research is that the qualitative data add clarity to the study where the quantitative statistics fall short. The qualitative data reveal that the Regulators'- viewpoint recognizes the concerns expressed by the other pole of Regulator viewpoint but rejects them in favor of BYOD. 01FS39 stated,

> *….These 2, I like know they're true, but I don't want to necessarily like-- 'opportunities for hacking' or 'putting your network in danger' like I as a teacher want to kind of ignore that that exists, because I want students to have like as much access as possible, but I get it's very real. We have to deal with it. So, like in my mind, they're true statements, but not necessarily positive things that are for BYOD, but like you do have to be aware of them….*

The Regulator- view sees perceived barriers for BYOD as surmountable by teachers,

> *….A lot of these here, like the 'haves' the 'have nots,' 'higher-end applications,' um 'teachers working through problems,' or 'conflicting with the needs of the classroom' - I think those are all based on how a teacher unrolls BYOD and how they foster that like discussion in their classroom, and how much they're invested in trying to figure out those problems. Because I think like in my case, I view a lot of these statements all as true, but I did everything I could to make them not an issue in my room.*

When it comes to students bringing their device charged to school (11: +4 for model and 11: -1 for 01FS39) the Regulator- view is explained as,

> *For example, 'Students will often forget to charge their devices.' Like I know very well from doing BYOD that this is absolutely true. I don't disagree with the statement, but I don't view this statement as being a positive one*

In Summary, the Regulator – view acknowledges the BYOD concerns of the Regulator + viewpoint but rejects them as surmountable in the pursuit of the benefits of BYOD.

To explain the Regulator- viewpoint fully it is necessary to go beyond the previously considered distinguishing factors and examine three additional distinguished factors from Table 10.

- I am not for BYOD (1: 2);
- I don't believe there is a benefit to BYOD (12: 1); and
- BYOD will increase cheating (10: -1)

While explaining where these items were placed in the Q-sort, 01FS39 said, *".... I 100% disagree with the statements under the 1 and even perhaps this 'increase cheating' I might have put underneath a 1."* With this declaration, 01FS39 expressed a very strong belief in favor of BYOD while rejecting cheating concerns.

In conclusion, the opposing Regulator belief is one that sees value in BYOD and sees concerns such as, students will often forget to charge their devices (11: +4), BYOD puts your network in danger from all the malware that student devices may have on them (25: +3), and BYOD provides an opportunity for hacking (21: +2), as conquerable by teachers. In addition, the Regulator- view strongly supports BYOD and its benefits, while rejecting concerns over a possible increase in cheating by students due to BYOD.

Factor 3: The Pragmatists

The distinguishing statements in Table 12 are used to define the overall viewpoint expressed by Factor 3 (Pragmatists). Table 12 identifies statements that Factor 3 ranked higher or lower when compared to the other two factors. A difference at the $p < 0.01$ level is represented with an asterisk (*).

Table 12.

Distinguishing Statements for Factor 3

Factor		1		2		3	
No.	Statement	Q-SV	Z-SC	Q-SV	Z-SC	Q-SV	Z-SC
34	Not all students can provide a BYOD device.	1	0.67	1	0.70	4	2.20*
33	BYOD gives the students unlimited access to information and resources.	0	-0.05	-4	-1.51	4	1.70*
5	With BYOD, students can use devices with which they are familiar.	1	0.38	0	-0.00	3	1.60*
29	The mix of BYOD devices in the classroom may conflict with the needs of the classroom.	-2	-0.72	1	0.58	3	1.45
19	Student familiarity with her/his own device is important.	0	0.27	-2	-0.93	2	0.94
15	A student's BYOD device is potentially a better device than what the school can supply.	0	-0.20	0	-0.23	2	0.78
23	Environments where every student has a device allows for enhanced collaboration.	3	1.69	-1	-0.81	1	0.27
32	BYOD allows students the opportunity to leverage down time between classes.	2	0.79	1	0.71	0	-0.16
18	BYOD could get technology into students' hands if you currently don't have it.	1	0.67	3	1.17	-2	-0.86*
27	BYOD provides possible cost savings.	2	0.83	0	0.69	-3	-1.02*

Table 12 provides the Q-SV and Z-SC for the distinguishing statements defining Factor 3 (Pragmatists) for comparison with Factors 1 (Integrationists) and 2 (Regulators±). It is clear from the data provided that PreK-12 technology leader viewpoints represented by the distinguishing statements for Factor 3 are distinct from those of the preK-12 technology leader viewpoints captured by Factors 1 and 2.

Factor 3 was identified as contributing to meaningful analysis in this study because it had an eigenvalue of 1.4138 and explained 11% of the study variance (Table 2). In addition, Factor 3 contained three significantly loaded participant sorts (Table 3). The data supporting Factor 3 were considered to have good reliability and a good measure of standard error (Table 8).

Participant demographics for Factor 3 included gender, school district typology, and the percentage of student poverty in the district represented. Factor 3 (Pragmatists) demographic data were comprised of the following:

- 1 male and 2 female participants loaded significantly for Factor 3;
- 1 suburban, 1 rural, and 1 town district are represented in Factor 3; and
- Student poverty of Factor 3 represents a range from 12% to 34%

Sixty-six percent of the participant sorts captured by Factor 3 were conducted by a female and 33% were conducted by a male participant. Factor 3 was predominately represented by females. Factor 3 participants worked in a wide variety of school typologies and they represented suburban, rural, and town districts. The significantly loaded participant sorts supporting Factor 3 represented districts with student poverty over a wide range. A synopsis of Factor 3 (Pragmatists) viewpoint follows. Rankings of relevant statements are provided. For example, a ranking of (6: +4) indicates that statement 6 was ranked with a +4 Q-sort value. Participant comments used to clarify, and support interpretation are cited and indicated by italic type.

The Pragmatists' Viewpoint

The Pragmatists place value in statements reflecting access concerns brought about by BYOD and the practical benefits associated with students using their own devices. The Pragmatist view point supports statements such as not all students can provide a BYOD device (34: +4), BYOD gives the students unlimited access to information and resources (33: +4), and with BYOD, students can use devices with which they are familiar (5: +3). Conversely, Pragmatists do not see BYOD increasing access by getting technology into students' hands if they currently do not have it (18: -2) or as providing a cost-savings to school districts (27: -3). The following is an excerpt from the dialogue recorded during Pragmatists' participant Q-sort, in describing why statement 34 was placed in the most agree column:

> ***Researcher:*** *So, tell me about it. Let's start with the ones on either side of the matrix. The most disagree or most agree. Why are those in the positions you put them in?*
>
> ***07MS12:*** *Well I just have seen-- as far as the, 'Not all students can provide a BYO device.' We implemented BYOD here I think around 4 years ago, 5 years ago. And we went through that initial 'haves and have nots' concern internally. Didn't really see the impact in the community that we thought we would have seen. As far as, 'hey, my son doesn't have an iPad' and this person bought an iPad. The correlation in the AT meetings was you know, the environment is you have 3 colored crayons and Johnny brings in a box of 48, you know. And the concern was that. From my point of view, I wasn't exposed of and I never heard in the meetings, that sort of feedback coming from any kind of bullying, any kind*

of teasing, any kind of 'haves and have nots' in the classroom. But we do know, we had a good amount of people that didn't have a device. Because it was brought up by the parents saying, 'we just don't have something.' There wasn't a sense of any kind of bullying in that aspect, but there was initially 'hey, we don't have something.' Although our school adopted BYOD, we never made it mandated into the classroom. So that is a real thing that we have parents in our community, and everybody always thinks that our community is premiere people, and everybody has it…

In support of this perspective, participant 12FT39 explained:

Researcher: *So, let's start with the most agree. So, you have - 'Not all students can provide a BYOD device.' Why was that one of your strongest agree statements?*

12FT34: *Probably because of the school district I'm in. I mean it's-- there's many students that wouldn't be able to provide their own.*

The Pragmatists' view of statement 18, BYOD could get technology into students' hands if you currently do not have it, was best explained by the following exchange:

Researcher: *That makes sense. So, you disagree with the statement - 'BYOD could get technology in students' hands if you currently don't have it in the classroom.'*

12FT34: *So, I guess my thought on that one was that if the school can't afford to have technology or get technology, then I'm thinking that the students probably can't be able to.*

Researcher: *Okay. This is interesting.*

12FT34: *[laughter]*

Researcher: *And it's certainly unique and that's a good thing.*

12FT39: *Okay.*

Researcher: *So, you're looking at that as BYOD and school budget as a reflection of the community? Okay. Yeah, I get that…*

Pragmatists see BYOD as providing unlimited access to resources in a practical way. The following dialogue exemplified the Pragmatist belief regarding statement 33:

Researcher: *Okay. On the other side we've got 'BYOD gives the students unlimited access to information and resources.' Why did you feel most positive about that?*

10FR39: *I picked that because even when they don't have their Chromebooks, they have their cellphones. And I imagine now that that's my BYOD, is their cellphones. So, they're using those for calculators during tests, they're using them for recordings. We do YouTube videos where we take a QR code and we tell a story for a student down at the elementary, like a book-- this is what this book about and then we put the QR code on there. But we can't do those on Chromebooks. The students are using their own devices to make those videos. But they don't see it as a BYOD. They just see it as 'oh, I'm just using my cell phone to make a movie, what are you talking about?'*

Researcher: *It's just what they do, right?*

10FR39: *Yeah. It's just what they do now. So, I don't think that they know they're doing it, but they are.*

Pragmatists just do not believe BYOD provides possible cost savings. Participant 10FR39 explained that point of view in the following exchange:

Researcher*: So over here, your most disagree, you got 'BYOD provides possible cost savings' is the one at the top of that column. Why did you put that one there?*

10FR39: *Well because it only provides cost savings if it's done well. And I don't think we did it well. And we had a lot of students who were still the 'have nots.' We still had to have carts and labs. We didn't change anything.*

Researcher: *So, you guys didn't see any device savings cost?*

10FR39: *Nothing. We still have our CAD labs. We still have our Photoshop labs with Adobe, the Adobe Suite. We couldn't do away with that. That's where the licensing was expensive, and the computers are more expensive because the graphics. And then we still had our labs where maybe teachers could share them more because maybe 10 kids in their class brought in a device, but the cart was still needed because you still had the 'have nots.' So maybe we got more people, more students using devices. But it didn't save us any money, because we still had to have all the things in place, in case somebody didn't have.*

Researcher: *Did your network cost increase? You would have had a NAC in place and all that anyways?*

10FR39: *Yes. Yes…*

In summary, Pragmatists expressed concerns about reduced access to technology associated with BYOD. These concerns connect the beliefs that not every student can provide a device with the belief that BYOD does not provide possible cost-savings. In the Pragmatists' view, any possible cost-savings are eliminated by the need to provide devices for students and the expenses required to support BYOD. However, Pragmatists see practical benefits of BYOD in that students are afforded the opportunity to use their own devices in relevant ways.

The Outlier

One participant, 05MS10, did not load significantly into any of the three factors, and did not fit the patterns of any factors. The demographics for 05MS10 were:

- Male;
- Works in a suburban district; and
- The district represented has 10% student poverty

Figure 5 is a visual representation of participant 05MS10's Q-sort.

Disagree Most								Agree Most
-4	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**
4	6	10	2	14	21	23	22	18
28	17	12	20	19	32	34	27	11
	3	33	25	30	26	9	31	
		15	8	7	16	1		
			13	5	29			
				24				

Figure 5. Q-sort of 05MS10 (Outlier)

This participant disagreed most with the statements, BYOD devices will not support the higher end applications we have in place (4: -4) and BYOD allows students to bring their technology to their learning, rather than having to adapt to the technology provided by the school (28: -4). This participant also disagreed with the view that environments where every student has a device allows expanded assessment methods (6: -3) with BYOD and students can use devices they have setup to their liking (17: -3). Conversely, 05MS10 agreed most with the statements, BYOD could get technology into students' hands if you currently don't have it (18: +4), students will often forget to charge their devices (11: +4), Environments where every student has a device allows for improved differentiation (22: +3), and BYOD provides possible cost savings (27: +3).

The following dialogue illustrated Participant 05MS10's views on the devices not supporting higher-end applications and students bringing their technology to learning as opposed to having to adapt to the school's technology.

> ***Researcher:*** *So, on the disagree side, the first 4 cards on the disagree side, the column 1 and the first 2 in column 2, we're your negative pile. So why do you see 'BYOD devices will not support higher-end applications that we have in place' as your most disagree?*
>
> ***05MS10:*** *I just don't think that's necessarily true, especially if-- it seems like the majority of those applications are web-based. So as long as their device is getting on the network, which a BYOD would imply, then I don't believe that that's true.*

Researcher: *And then the one right below that, 'BYOD allows students to bring in technology to their learning, rather than having to adapt to the technology provided by the school'?*

05MS10: *Again, because it's web-based, I'm not sure they're going to have a whole lot more access to things that the school can't provide for them... And you know in some cases it's not like they're all coming with MacBooks, and we're providing ChromeBooks. A lot of them had ChromeBooks and then we provide them ChromeBooks. So, it was the same level, or it wasn't enough for me to say like 'oh, for sure.' Or we provide some other opportunity at school that they can still have access to that, like we have a Mac lab, even though we are a 1 to 1 ChromeBook building at the high school.*

When discussing the most agree statements, 05MS10 explained his view of BYOD getting technology in the hands of students in the classroom in a practical way. He also shared a view of students forgetting to charge their device based on his school districts experience with their 1-to-1 technology program.

Researcher: *Alright. On the other side, most agree - BYOD could get technology into students' hands in your classroom if you currently don't have it.*

05MS10: *Right. I just-- I mean I couldn't disagree with that. If you are hurting financially or just the plans weren't budgeting for it and you know your network can support it, like, yeah, I think absolutely.*

Researcher: *That makes sense. And 'students will often forget to charge their devices' is your--*

05MS10: *Yeah. Yes, absolutely. We're seeing that.*

Researcher: *Okay.*

05MS10: *Yeah. That's why we have decided not to send the devices home at the middle school, because 'forgot to bring it' or 'forgot to charge it' are the 2 most common things.*

The school district 05MS10 works for tried BYOD at the high school several years ago. 05MS10 described some aspects of that experience in the following exchange.

Researcher: *Anything else you want to tell me about your sort?*

05MS10: *Um even though, you know I'm more in favor of our setup with the 1 to 1, you know I still put largely in the disagree column, 'I don't think there is a benefit with BYOD.' It depends on your district, you know. I don't think it's a bad thing, we thought we just had something that fits best for us.*

Researcher: *So, it didn't work for you guys?*

05MS10: *Right… We were able to provide enough for every kid, so we did. But if-- but if the goal is getting a device in every kid's hands come hell or high water, then--*

Researcher: *BYOD might be able to provide that?*

05MS10: *Yes. Yeah. I certainly understand why some districts do that.*

In summary, the outlier viewpoint belongs to a male working in a low student poverty, suburban district. The outlier views accessed higher-end applications as something the school can provide, but BYOD would not prevent using those applications.

In 05MS10's school district, access was to high-end applications using high-end Apple devices or through online resources available on all devices. The outlier understood why other schools might pursue BYOD for financial reasons. However, the outlier had a negative experience with BYOD and does not see value in it. The outlier preferred to get technology in the hands of students using a 1-to-1 model.

Similarities Between Factors: The Global Viewpoint

This section will examine similarities between the Factors through an inspection of consensus statements (Table 13), which are items that did not distinguish themselves for any of the individual factors and by comments made by the participants (presented in italic type). Q-sort arrays, representing the Q-sort for each participant, can be found in Appendix C. The demographics for the Global view were:

- 4 females and 9 males;
- 8 suburban, 1 urban, 2 rural, and 2 town districts;
- 6 schools with student poverty falling in the range of 7% - 21%; and
- 7 schools with student poverty falling in the range of 34% - 49%

Sixty-nine percent of the Global viewpoint belongs to male participants and 31% to female participants. These gender percentages align with the larger population of K-12 technology leaders (n=478) surveyed by CoSN in 2018. CoSN (2018) reported gender demographics of 70% male and 30% female. The current study is representative of a majority suburban school districts (61%). Student poverty is split between schools with 7% - 21% student poverty and 34%-49% student poverty.

The consensus statements in Table 13 are statements that loaded similarly for all factors in the current study. All statements are non-significant at *p*>.01; those flagged with an (*) are non-significant at *p*>.05.

Table 13.

Consensus Statements of the Global Viewpoint

		Factors					
		1		2		3	
No.	Statement	Q-SV	Z-SCR	Q-SV	Z-SCR	Q-SV	Z-SCR
3*	BYOD allows students to have opportunities to use devices and navigate seamlessly between them.	-2	-0.99	-3	-1.39	-3	-1.04
4*	BYOD devices will not support the higher end applications we have in place.	-3	-1.34	-2	-1.17	-2	-0.96
9*	It's much better for the school to provide consistent, reliable devices for every student.	2	1.18	1	0.69	2	1.13
20*	Students have the opportunity to see how a variety of devices work.	-2	-1.03	-1	-0.81	-1	-0.48
30*	BYOD increases the perceived social pressure of the "haves vs. have-nots".	2	0.73	2	0.93	3	1.3

Note: All statements are non-significant at *p*>.01. Those with an * are non-significant at *p*>.05.

The consensus statements reveal a communal viewpoint (Global) shared by the Integrationists, Regulators±, and Pragmatists. The five statements in Table 13 are significant for all of the participants who loaded into any of the 3 Factors examined by the current study. PreK-12 technology leaders did not place value in BYOD's providing opportunities to seamlessly navigate between devices and students having the opportunity to see how a variety of devices work. Globally, PreK-12 technology leader participants took a negative view of BYOD devices not supporting higher-end applications:

Researcher: *You most disagree-- this is the area you seemed most confident with. These 2 you didn't have any problem finding a spot for. Why is that?*

09MR48: *Well supplementary speaking, even if we were a 1 to 1 school, I think there is some benefit to having BYOD. Because say since we are Chromebook based, there's going to be times where maybe we don't have a device for a specific program that we can run here. Maybe a student who does graphic design or something on their laptop, they could bring their own device in and run that program for maybe a robotics competition. Um 'BYOD allows opportunities for students to use multiple devices and navigate seamlessly.' I hate to say it, but even the kids who have multiple devices do not navigate multiple devices seamlessly.*

Researcher: *Okay.*

09MR48: *They seem to run into issues. They need help. They need troubleshooting. So that word seamlessly charged that statement to me.*

The Global perspective believes that the schools should provide the devices. Frequently, the Global viewpoint on schools providing student devices took the form of discussions around 1-to-1 technology programs or in the context of State testing and application management. Globally, PreK-12 technology leaders saw school-sponsored 1-to-1 as providing a uniform set of capabilities for uniform instruction.

13MT47: *We'd like to be 1-to-1. We're not quite there yet systemwide…. I mean, we have such a mix in our district. We focus our K-2 buildings with the iPads, but* *they have some Chromebooks as well, all the way down to our kindergarten teachers. Um you know we like to have the youngest kids with that tactile feedback type of device, but yet we also like to encourage writing, and we just feel writing on a Chromebook with a keyboard is so much better um at any grade level quite honestly….*

The Global viewpoint revealed, even when school districts have been engaged in BYOD for years, schools find themselves moving into 1-to-1 because of state testing and because Chromebooks are easy to manage.

Researcher: *So, your BYOD trajectory has been, you've been all in on BYOD, is that fair to say, for the past 6 years?*

11MS21: *Yes, and we've been slowly and steadily purchasing Chromebooks throughout the years. So, because you can't, the one thing that BYOD cannot do is it can't do state testing… That's the differentiator…. And the management of a Chromebook versus group policy Windows, I mean it's not even comparable. So, we're like, well let's get some Chromebooks and we can use those for online testing in collaboration with our computer labs. And as we got more Chromebooks, we tore down more computer labs. Then we got more Chromebooks and took out even more computer labs…. We didn't fall into 1 to 1, but we have been on the slow steady march to 1 to 1. Because we just have been buying more and more devices, so it's like you wake up 1 year and you're like 'shoot, we're at 75% 1 to 1.' Actually, we're more than 1 to 1 now if you look at the number of PCs we have in the district, the number of iPads we have in the district.*

Globally, K-12 technology leaders in the current study may have tried or at least considered BYOD. Globals found that it does not work as a reliable pedagogical approach, and they believed that 1-to-1 is a superior model.

> ***Researcher****: Okay. So, you guys do 1 to 1 with take home. Did you ever consider as a school district BYOD as an alternate? Or-- why 1 to 1?*
>
> ***02MS11:*** *I've personally gone back and forth on this about a hundred times. Because I-- where's the one that says 'students bring their technology to their learning'? Which is sort of what the holy grail should be, right? Where instead of having them conform to our technology, that they bring their technology and learn with it. I think that is a great model. Um I think that's a model we grow into. So as kids get older, they get an increased level of independence. And I think with technology, that's the case as well. But at the elementary level, all of the students are doing the same thing in a very prescribed way on a device that the district provides. Our original plan for digital learning was that as the students get older, they become more independent. So, you get to second grade, third grade, you've got computers in a cart and they stay in the room and the teacher's keeping an eye on everything and they're all configured the same way, and everybody's doing the same thing at the same time. You get to middle school, now it's the school's device, they're all configured, technically we're supporting all of them, we're providing all the learning tools, but the kids get to take them home. And then when they get to high school, they're bringing their own device to their learning. Now it didn't work out that way. We ended up providing the devices for the kids. But I think as they get older, we want to get to the point that when they*

leave us, they can use their own devices and have more agency in the tools that they're using.

03MU49: *So, we are not a 1 to 1 district. And that is kind of where this comes in too, is we were—when I got here, we had no Chromebooks, we had no Google, we had nothing. So, we had BYOD, but we didn't have a lot of direction put on BYOD… So, you know, we've started integrating Chromebook carts into classrooms, but the per—in a perfect world we would be 1 to 1…*

Researcher: *How long had you-- how long would you say you'd been doing BYOD?*

06MS49: *Three years.*

Researcher: *Three years? And why are you phasing it out?*

06MS49: *Because we're rolling up a 1 to 1.*

The Global perspective viewed statement #30 regarding BYOD increasing the pressure between the "haves vs. have nots" as a reality. Participant 08MS07 saw the equitable access problems BYOD creates as an obvious problem.

Researcher: *Okay. So BYOD increases the perceived social pressure of the haves versus the have nots.*

08MS07: *Not all students have one--*

Researcher: *So, if they can't bring a device, there's the pressure-- is that what you're saying?*

08MS07: *Yeah. I'd like to move one of these over here and put this in the same column... These are all true statements in my opinion... I mean this one I consider silly, it's obvious. It's just 'the sky is blue,' you got to agree with it the most.*

The complexity of the perception that BYOD creates equitable access concerns between students who can afford devices in comparison to those who cannot was exemplified in the following exchange.

10FR39: *And I can see-- I was conflicted because I can see how it (BYOD) could work in schools. It just didn't here. We tried that first. And we did have the 'haves' versus the 'have nots', but some of the 'haves' still didn't bring it in, because they didn't want to be perceived as a 'have.'*

Another participant explained simply***, Researcher:*** *You don't have a 'haves' or 'have nots' issue?* ***11MS21:*** *We do.*

In summary, the Global view represents the view that BYOD provides some benefits in terms of enabling access to all kinds of learning resources including higher-end ones. However, the Global perspective is that 1-to-1 is a better model. Several of the school districts represented in the current survey are moving away from BYOD towards 1-to-1 due to issues connected with mandated testing requirements and equitable access concerns.

Summary

In this chapter, the data collected from the Q-sorts of 13 PreK-12 technology leaders working in either Ohio or Pennsylvania were analyzed and explained using Q methodology. Software specifically designed for use in analyzing Q methodology data, PQMethod 2.35 for Windows, was used to perform the quantitative statistical analysis. Researcher evaluation of each transcribed Q-sort yielded the qualitative data informing the study results.

A correlation matrix indicates that the data collected as Q-sorts contains viewpoints with a level of correlational significance encapsulating a set of factors likely to provide meaningful analysis. PCA identified a three-factor model explaining 57% of study variance. Each of the three identified factors containing defining Q-sorts and Z-scores for each factor provided evidence that each one represents statements of agreement (positive score) or disagreement (negative score). The factors are distinctly different from each other and have good composite reliability.

Consequently, each factor represents a different perspective. The Integrationist factor believed that technology, in all its forms, plays a positive role in teaching and learning. The Integrationist view partnered technology with instruction in a way that amplifies the importance of pedagogy over the type of device. The Regulators'± view represented a bipolar or binary factor. Regulators + viewpoint reflected a concern about BYOD and the problems it introduces to the school environment. A Regulator+ does not see BYOD as contributing to improved school-to-home communications or in providing unlimited access to information and resources. The Regulators'- viewpoint was the polar opposite of the Regulators'+ viewpoint and it is that opposition that fully informs the Regulators'± view point. The Regulator- view saw value in BYOD and saw the concerns raised in the Regulator + view as conquerable by teachers. In addition, the Regulator-view strongly supported BYOD and its benefits while rejecting concerns over a possible increase in cheating by students. The third factor, Pragmatists, expressed concerns about reduced access to technology associated with BYOD. These concerns connected the beliefs that not every student can provide a device with the belief that BYOD does not provide possible cost-savings. Pragmatists saw practical benefits of BYOD in that students are afforded the opportunity to use their own devices in relevant ways.

The Global viewpoint, as identified using consensus statements not loaded into any of the 3 factors, revealed the Global view as one representing a viewpoint that BYOD may provide some benefits in terms of providing access to all kinds of learning resources including higher-end ones. However, the Global perspective believed 1-to-1 is a better model than BYOD.

The data analyzed in this chapter will be discussed and used to answer the research questions in the next chapter.

Chapter 5

Discussion

Summary of Findings

The current Q methodology study pinpointed a three-factor model that uncovered a unique glimpse into the perspectives of Pre-K-12 technology leaders regarding BYOD. Similar results would have been elusive using traditional R Methodology, a standard survey might not have revealed the critical points of interest that Q methodology divulged.

Data analysis using PQMethod 2.35 for Windows identified the following factors. The Integrationists represent 31% of study variance, The Regulators± is a binary factor resulting from both positive and negative factor loadings representing 15% of study variance, and The Pragmatists represent 11% of study variance.

The Integrationists' critical distinction is the strong belief that any technology in the hands of students is valuable for instruction. Their belief in the benefits of technology are not tied to BYOD and they dismiss the idea that BYOD creates problems for teachers.

Throughout this study, the Regulators' point of view is presented in a complex manner due to the binary (bipolar) nature of the factor loadings; this elaborate presentation is necessary for accuracy and for the richness of interpretation it provides. However, the complexity of the presentation may make the Regulators' views a bit baffling to understand. Seeking clarity, it is possible to simplify the Regulators' beliefs by focusing only on a combined factor interpretation. This is possible because each pole contributes to the overall combined viewpoint. Simply put, the critical distinction of the Regulators' point of view is that they, as a combined factor, do not find any benefits to BYOD. Consequently, Regulators see BYOD as having many drawbacks like students not remembering to charge their devices, BYOD facilitating excess bandwidth use, and BYOD providing for an increase in hacking.

The critical distinction for Factor 3, the Pragmatists, is that they see BYOD creating problems with students not having equitable access to technology; they are concerned about the haves vs. have nots. Pragmatists are realistic about costs associated with BYOD but believe students' access to devices they are familiar with is important.

Globally, BYOD is seen as not facilitating students' abilities to use or navigate between multiple devices and 1-to-1 is seen as a better model than BYOD.

Answering the Research Questions

The purpose of the current study was to examine and emphasize the importance of Pre-K-12 technology leader perspectives of BYOD programs in an effort to provide insight into a topic missing from existing BYOD research. To accomplish this goal the current study examined the following research questions using Q methodology:

1. What are the benefits of BYOD from the Pre-K-12 technology leader perspective?
2. What are the drawbacks of BYOD from the Pre-K-12 technology leader perspective?

This section examines data extracted from the Q-sorts and interviews. The unique mix of data gathered in this study provides the information needed to answer the research questions. Answering the research questions requires a reexamination of the data looking for areas of unanimity among the study participants.

Research Question 1: What are the benefits of BYOD from the Pre-K-12 technology leader perspective?

The researcher examined each of the viewpoints presented in Chapter 4 to identify ways in which each factor identified benefits of BYOD. Table 14 contains the benefits of BYOD singled out by each Factor interpretation and the Global viewpoint along with the amount of study variance each Factor represents. An asterisk (*) indicates shared variance.

Table 14.

Benefits of BYOD

Factor/Viewpoint	Benefits	Variance
Integrationists	Technology is viewed as positive for instruction but not necessarily connected to BYOD. Technology provides for improved collaboration, differentiation and assessment methods. Reject the concept that BYOD creates problems for teacher.	31%
Regulator+	BYOD does not increase cheating	15%*
Regulator-	BYOD provides unlimited access to information and resources. BYOD provides for enhanced collaboration. Student familiarity of the device is viewed as important.	15%*
Pragmatists	BYOD provides unlimited access to information and resources. Student familiarity of the device is viewed as important.	11%
Global	No benefits identified.	

Note: The Regulator± views share 15% of study variance due to a binary factor loading

Individual factors identified some benefits of BYOD. In the current study BYOD is seen as providing unlimited access to information and resources. BYOD and technology in general enable the benefits of improved collaboration, differentiation, and expanded assessment methods. BYOD also provides students the benefit of using devices with which they are familiar. The Global perspective identifies zero benefits to BYOD as it prefers that the school provide the student a device using a 1-to-1 model.

Research Question 2: What are the drawbacks of BYOD from the Pre-K-12 technology leader perspective?

The researcher examined each of the viewpoints presented in Chapter 4 to identify ways in which each point of view identified the drawbacks of BYOD. Table 15 contains the drawbacks of BYOD singled out by each Factor interpretation and the Global viewpoint along with the amount of study variance each Factor represents. An asterisk (*) indicates shared variance.

Table 15.

Drawbacks of BYOD

Viewpoint	Drawbacks	Variance
Integrationists	No drawbacks identified.	31%
Regulator+	Students will not remember to charge their devices. BYOD facilitates excess bandwidth use. BYOD provides for an increase in hacking. Does not improve communications. Does not improve access to information and resources.	15%*
Regulator-	No drawbacks identified.	15%*
Pragmatists	Not all students can provide a device. Does not provide a cost-savings. It will not get technology into students' hands when the school cannot afford them.	11%
Global	Students are not able to navigate seamlessly between devices. BYOD creates equitable access problems due to issues surrounding haves vs. have nots.	

Note: The Regulator± views share 15% of study variance due to a binary factor loading

Individual factors identified some drawbacks of BYOD. In the current study, BYOD is seen as creating problems when students forget to charge their device, increasing opportunities for hacking, and not improving school-to-home communications. BYOD is viewed as having an inherent drawback in not providing equitable access to technology because some families can afford a device (haves) and other families cannot afford a device (have nots). If families cannot provide a device, BYOD is not going to get technology into the hands of a student when the school cannot afford technology. Globally, BYOD is seen as not facilitating a students' abilities to use or navigate between multiple devices.

Interpretation of Findings

In the current study, BYOD is seen as less of a pedagogical approach and more as a technical one that grants access to the school network and online resources. This might be attributed, at least in part, to the population from which the participant sample was drawn. The two primary paths to becoming a Pre-K-12 technology leader are either through a professional background in technology or instruction (CoSN, 2018, p. 7). Frequency statistics provided by the demographic information collected during the initial Survey Monkey survey reveal that 58% of the Pre-K-12 leaders came from a background in technology or a technical field, whereas 29% came from an education or instructional background. The current study drew participants from a sample that was dominated by professionals with technical backgrounds. This dominance may be partly responsible for the technical lean evidenced in the drawbacks to BYOD identified by the study. In the current study, BYOD is seen as creating problems when students forget to charge their devices, increased opportunities for hacking, creating excessive bandwidth usage, not providing a cost-savings, exacerbating equitable access concerns, and not improving school-to-home communications.

While a technical perspective may have impacted the drawbacks' results of the study, technology's role in pedagogy was not missing from the benefits identified by participant viewpoints. In particular, the Integrationists' and Regulators' – views discussed the benefits of technology in teaching and learning. Integrationists see technology improving collaboration, differentiation, and assessment methods. It is important to note that the Integrationists, representing 31% of study variance, do not see BYOD providing benefits to teaching; they view technology in all its forms as being beneficial to instruction. This distinction is important because it provides evidence of a tarnished view of BYOD despite the Integrationists' view reveling no drawbacks for BYOD. The Integrationist sees any potential drawbacks as effects that can be overcome in pursuit of perceived benefits of technology integration. Participant 01FS39 (Regulator-), formerly a teacher in a successful BYOD classroom, understood and valued BYOD. However, participant 01FS39 now promoted 1-to-1 as a Pre-K-12 technology leader.

The trend of schools in the current study moving away from BYOD (or not even considering BYOD) in favor of 1-to-1 was a bit surprising but not entirely unexpected. CoSN survey results from the past several years revealed a continued decline in interest by schools in starting new BYOD initiatives. The current study reveals some technical concerns and equitable access concerns that may be driving schools away from BYOD. However, it is reasonable to assume that schools would not move away from BYOD if it was viewed as a superior teaching and learning strategy since schools, after all, are in the teaching and learning business. The current study does not support a Pre-K-12 technology leader viewpoint that BYOD, in and of itself, improves teaching and learning. This study supports the viewpoint that technology, in all its forms, is believed to be good for instruction and that 1-to-1 is the preferred way to get technology in the hands of students.

Context of Findings

Pre-K-12 technology leaders are the men and women in senior-level school technology leadership positions. Frequently, these senior-level school leaders are high academic achievers (CoSN, 2018, p. 6). The demographics of the Pre-K-12 technology leaders surveyed for concourse development indicate that 54% of survey participants have some college beyond a bachelor's degree. Of this sample, 58% indicated that they have been in their current leadership position for less than five years and the next most frequently indicated response for years of service was 11-20 years (20.8%). Nearly all of the Pre-K-12 technology leaders surveyed during concourse development were White (95.8%), while only 4.2% indicated Hispanic origin. As a point of context, the CoSN (2018) reported ethnicity values in their study as being 90% White, 2% Black, and 2% Hispanic origin. It is Pre-K-12 education technology leaders like these who are responsible for providing support for both the instructional technology and the technology used for administration of the school district (CoSN, 2017). The role of the Pre-K-12 education technology leader is complex and serves as the centerpiece of school technology leadership. As central figures responsible for school technology decision-making, the Pre-K-12 technology leaders' beliefs and values shape the decisions made regarding school-wide technology initiatives. This study examined Pre-K-12 technology leaders' beliefs regarding BYOD using a mixed method approach that provides deeper insights into some of the scholarly work examined in Chapter 2.

Technological determinism in education asserts that learning outcomes are driven by the inherent characteristics of the technology itself, independent of teacher influences (Bigum, 1997, p. 249). It is believed, by Technological Determinists, that technology has the agency to change teaching and learning. This belief devalues the role of the instructor, school leadership, and family in student achievement. Some research indicates that Pre-K-12 technology leaders feel pressure to keep up with changes in education technology or their students will be left behind (Webster, 2017). This study did not measure the Technological Determinists' or the Social Construction of Technology (SCOT) beliefs of its participants. However, the unique mix of data collected does provide some limited insight into this topic of scholarly interest.

Sixteen-percent of the concourse development survey questions addressed participant views regarding technology determinism. For analysis of the technological determinism questions, the data from the Survey Monkey survey was imported into IBM SPSS Statistics version 24. Full analysis of the 8 Likert scale technological determinism questions is provided in Appendix D. Of the sampled population (N=18), 94% agreed or strongly agreed with the technological determinists' statement, "Technology has the power to alter the very essence of daily life." The exact same percentage (94%) of concourse survey participants agree or strongly agree with the soft determinists' statement, "Technology is the product of human actions- its power to change society is a product of the time and place in which it is introduced." When presented with a SCOT perspective statement, "Society controls and shapes the impact of technology on daily life", concourse survey participants felt less strongly, agreeing or strongly agreeing 72% of the time. This limited data set suggests that the Pre-K-12 technology leaders surveyed tend to have a determinist point of view; likely, a soft one. This data, while interesting, were not the data examined in depth by this study. The current study examined the *beliefs* held by its participants regarding the benefits and drawbacks of BYOD. The Q-sort data analyzed also provided some limited insight into participant views of technological determinism and SCOT.

Looking carefully at the Q-sort data for the presence of technological determinism revealed a few hints of what the study's participants' determinist or SCOT viewpoint might be. It can be interpreted from the emphasis that the Integrationists' and the Regulators'- views place on the benefits of technology for instruction, along with the devaluing of potential problems BYOD creates for teachers, that the Integrationists and Regulators- lean towards a Technology Determinist point of view. Statements like the one made by 09MR48 while discussing the importance of technology in the classroom, *"…that is one of the key facets to providing a learning environment that allows all to succeed…"* or when participant 01FS39 said*, "…in my mind it's about access to technology regardless of where it comes from…",* and when 06MS49 stated*, "On the agree most side, uh I think that any tool we can get on the internet and provide access is a key for students. That's where our future is…"* lend support to the assertion that the Technological Determinists' points of view were present in the study's participants. There were no obvious SCOT points of view expressed by the participants. Concerns regarding the social issues connected to equitable access to technology indicate that the study's participants were aware of and engaged with the connection between technology and society. In dealing with equitable access concerns, participants globally believed that it is best for the school to provide the device so that the benefits of technology in the classroom can be achieved. This view can be interpreted as a soft determinist viewpoint. Technology is so important for student success that real social factors, like poverty, should not be allowed to prevent it. Not unlike Webster's (2017) study, participant 02MS11 expressed that there was pressure from the community to provide students devices. This pressure is the reason that they stopped pursuing BYOD and are now following a path towards 1-to-1. Webster's (2017) study also believed that educational goals and curriculum should be a primary factor in technology adoption. However, the two competing beliefs, one espousing keeping pace with technology for technology's sake and the other in which technology adoption is driven by pedagogy, create cognitive dissonance in Pre-K-12 technology leaders (p. 33). Some limited evidence of this duality in the current study was clear. The Integrationists, Regulator - and Pragmatists see instructional benefits to technology; for these groups, pedagogy is a driver. In addition, there does appear to be some pressure to provide devices for all children as evidenced by the prevalence of 1-to-1 initiatives. The belief that getting technology into students' hands is too important to be left up to a family's ability to provide a device is not only softly deterministic, but it is also a reflection of 21st century skills' initiative values.

Technology integration is the incorporation of technology into classroom settings that, when used effectively, results in meaningful student-centered learning practices. In the current study the Integrationist viewpoint expressed this ideal best. An Integrationist believes that technology integration provides for improved collaboration, differentiation, and assessment methods. Collaboration, differentiation, and diverse assessment methods are reflective of student-centered teaching practices. In addition, Pragmatists believe that BYOD provides unlimited access to information and resources and that student familiarity of the device is viewed as important. These beliefs also reflect student-centered values. The current study supports the expanded definition of technology integration as proposed in Chapter 2.

According to the literature, financial reasons have been identified as a primary motivator for schools who consider BYOD (Arnold, 2015; Ackerman & Krupp, 2012; Cavanagh, 2015; Chernoff, 2018; McLean, 2016; Nelson, 2012; Parsons & Adhikari, 2016; Traxler, 2016; Weinstock, 2010). Many authors propose that a more traditional 1-

to-1 technology initiative, in which the school pays for the device along with software and support, is quite expensive (Cavanagh, 2015; Cristol & Gimbert, 2014; Chou, Chang, & Lin, 2017; Kiger & Herro, 2015; Weston & Bain, 2010). This did not appear as much of a concern for the Pre-K-12 technology leaders in the current study. Only the Pragmatists expressed concerns about costs, and in their case, those concerns extended to costs associated with BYOD. This result is surprising as the literature overwhelmingly indicates financial reasons as the prevailing driver for schools pursuing BYOD. One participant (13MT47) provided the following speculation when queried about his views on the possible cost savings of BYOD:

> *Yeah. That's an interesting one to me because you know, so much of the changes in technology these days are quite frankly driven from financial perspectives. You know BYOD and I think-- part of me thinks a bunch of treasurers got together at a meeting and said, 'how could we-- why are we spending so much on devices and technology, how could we do that?' So their thinking started leaning districts to do more BYOD and outsourcing of shared services. Okay? Those are 2 things honestly that work counterproductively to the best interest of the school district, but it's certainly in the best interest short term of the financial status of a school district. So this statement, it provides possible cost savings, it certainly is possible but on the back end it creates so much more support work that needs to be done, that I think that it negates so much of the savings of having-- ....I think that when you start throwing out things like 'it's going to be a big cost savings thing' I think that's a little bit deceptive.*

This speculation, while interesting, is without evidence in the scholarly work reviewed by this study. One scholarly work reviewed for this study did provide evidence of possible reasons for the reduction of the financial driver.

According to CoSN (2017) the reduction of the BYOD financial driver is the result of, "New Microsoft Windows-based devices that are priced for the education market and the enhanced functionality of the already-affordable Chromebooks are likely to continue to reduce the need for and interest in BYOD strategies" (p. 17). The current study supports this assertion as 10 of 13 (77%) participants mentioned that they used Chromebooks extensively in their schools. These same participants either are already 1-to-1 in their school or aspire to be a 1-to-1 school. The following exchange exemplifies this finding.

Researcher: *How long have you guys been doing BYOD?*

11MS21: *2003.*

Researcher: *Wow. Long time.*

11MS21: *Teachers are rebelling, which is why I'm buying 3,000 Chromebooks.*

Researcher*: Oh, are they tired of the BYOD? They want to do the--*

11MS21: *One to one*

In addition, CoSN (2017) asserted that "other factors that could be contributing to a move away from BYOD include online assessment requirements, interoperability issues, and equity challenges" (p. 17), which is also supported by this study. Previously, it was established that study participants (Pragmatists) view access concerns as a drawback to BYOD and in Chapter 4 the Global view revealed that State testing is a driver for some schools to move away from BYOD. The prevalence of 1-to-1 schools in the current study indicates that the first order barrier of not having adequate access to technology has been greatly reduced or removed in the schools represented.

The concept of a seamless learning environment is characterized by the ability for students to learn anytime and anywhere using technology (Adhikari et al.; Chen, 2015; Cristol & Gimbert, 2014; Crompton, Burke, & Gregory, 2017; Gillies, 2016; McLean, 2016; Parsons & Adhikari, 2016; Song, 2014; Thomas & Munóz, 2016). A seamless learning environment can be connected to participant statements regarding students' seamless transition between devices. Participant 01FS39 thought that this skill is valuable enough that she would pursue this benefit through BYOD even if she taught in a 1-to-1 classroom. *"I would argue though that if you gave me 1 to 1 in the classroom, I would still want the capability of BYOD with that 1 to 1, because I've seen the value of differing devices."*

Take-home privileges in a 1-to-1 program support the concept of a seamless learning environment. One-to-one programs with take home privileges (4) are not as common as 1-to-1 programs without those privileges (5) in the schools represented by the current study. Of those schools that allow students to take devices home, only one plans on doing so with every student, the others restrict take-home privileges to specific grade levels. The Global view opposes the notion that students can move seamlessly between devices, and take-home privileges are typically either nonexistent or are restricted in the schools represented in this study. Consequently, this study does not support the concept of a seamless learning environment as a primary motivator for schools in pursuing BYOD or 1-to-1.

Implications of Findings

The findings in this study should be considered if a school or school district are considering BYOD. The Pre-K-12 technology leaders in this study see many benefits to technology in classrooms but not necessarily BYOD. These benefits support a desirable set of student-centered pedagogical practices. The same set of participants identify a number of technical concerns regarding BYOD and an important social concern regarding equitable access problems BYOD is believed to exacerbate. While technology integration in classrooms is globally viewed as vital in this study, BYOD is not the preferred method for achieving ideal levels of meaningful student-centered learning practices; 1-to-1 is preferred. Schools considering BYOD may need to adjust their expectations regarding the potential value of BYOD. This research may also help a school decide between 1-to-1 or BYOD. Understanding what the central figure responsible for school technology decision-making in their organization believes regarding BYOD can be valuable in appropriately adjusting expectations thereby improving outcomes for teachers and students alike.

Discussion of Limitations

This research study was limited to Ohio and Pennsylvania Pre-K-12 technology leaders. This limitation, along with the nature of Q methodology research, makes generalizing the findings to other populations problematic. In Q methodology the findings should only be applied to the population providing their subjective opinions. The survey instrument contained a mixture of survey questions created by the CoSN for their annual K-12 IT leadership survey and survey items created by the researcher. This study was, in small part, an analysis of those survey items. The CoSN survey questions primarily provided a reference point for many of the demographics presented in this chapter. The demographics presented in Chapter 5 are either those of the concourse survey participants or the CoSN survey participants. Study participant demographics were provided in the factor analysis of Chapter 4. The majority of the researcher-created survey questions were used as part of the concourse development process to identify the 34 Q sample statements used in the study. The researcher-created questioning process provides an opportunity for researcher bias to be introduced into the statements used in the Q sample. To counteract this possibility, actual statements provided by survey participants were used in forming the Q sample. This Q methodology study measured the individual views, beliefs, and values of its participants. Consequently, the process of the Q-sort is a subjective one: the participant applies his/her own meanings to the items being sorted at the time of the sort. As a result, the same items presented to a single participant at different times might produce different results. This does not indicate a problem with the reliability of Q methodology, but, reliability of the participant viewpoint (Watts & Stenner, 2012). Participant views present in this study were limited to the items presented to and the time and place they are presented to each participant. The current study used a measure of composite reliability in an effort to ensure that the three-factor model identified using participant response met with acceptable reliability standards. Ultimately, a Q methodology study relies on the honesty of the participant responses.

Discussion of Future Directions of Research

The findings presented in this chapter raise questions not addressed by the current study. Specifically, Pre-K-12 technology leader beliefs regarding technological determinism were not directly addressed by the study. An alternate study that includes a second Q-sort on the topic of technological determinism and/or SCOT would likely make Pre-K-12 technology leaders' views on those topics much clearer. It might also be enlightening to quantify the frequency of technological deterministic sales pitches and advertisements present in the large-scale education technology conferences that are attended by Pre-K-12 technology leaders. A broader picture of the role of technological determinism on the decision making of Pre-K-12 technology leaders could be helpful in reducing the practice of purchasing technology without a clear teaching and learning outcome in mind. The scholarly work cited in this work and the findings of the current study are not enough to fully understand the role this concept plays in schools.

In addition, it might behoove the global understanding of BYOD to conduct a Q method study similar to the current one with other important school district stakeholders like parents, students, teachers, principals, superintendents, treasurers, and boards of education. In particular, the principal's perception of how BYOD and technology in general is to be used is an important factor in successful technology integration (Dawson & Rakes, 2003; Garcia & Abrego, 2014; Levin & Schrum, 2012; Waxman, Boriack, Lee, & MacNeil, 2013). While there is some scholarly work identifying teacher perceptions of BYOD, a Q methodology study would assist in the understanding of those perceptions. Teachers and their technology beliefs are a critical component in successful technology integration (Admiraal et al., 2017; Chen, 2008; Ertmer & Ottenbreit-Leftwich, 2010; Gil-Flores et al., 2017; Glassett, 2007; Hermans, Tondeur, van Braak, & Valcke, 2008; Hew,

& Brush 2007; Kim et al., 2013; Liu, 2011; Petko, 2012; Prestridge, 2012; Vongkulluksn et al., 2018). Superintendent's, Treasurer's and Board of Education members provide the leadership and financial resources needed for school technology initiatives like BYOD. The views identified by conducting a Q methodology study, similar to the current one, with additional school stakeholder demographics would help to fully explain the function of BYOD in today's school.

Any further exploration of Pre-K-12 technology leader views of BYOD should consider asking questions specific to the nature of how of BYOD computer networks are used. The data gathered in this study led the researcher to speculate that BYOD has or is becoming a synonym for the school's guest network. The BYOD network may be evolving into a way to get student and teacher devices on school wireless networks while at school with few pedagogical expectations. BYOD, like guest access, may be permitted but not always encouraged.

References

Ackerman, A. S., & Krupp, M. L. (2012). *Five components to consider for BYOT/BYOD*. International Association for Development of the Information Society. Retrieved from https://files.eric.ed.gov/fulltext/ED542652.pdf

Adhikari, J., Mathrani, A., & Scogings, C. (2016). Bring your own devices classroom: Exploring the issue of digital divide in the teaching and learning contexts. *Interactive Technology and Smart Education*, *13*, 323–343. doi:10.1108/ITSE-04-2016-0007

Adhikari, J., Scogings, C., Mathrani, A., & Sofat, I. (2017). Evolving digital divides in information literacy and learning outcomes: A BYOD journey in a secondary school. *International Journal of Information and Learning Technology*, *34*, 290–306. doi:10.1108/IJILT-04-2017-0022

Admiraal, W., Louws, M., Lockhorst, D., Paas, T., Buynsters, M., Cviko, A., Kester, L. (2017). Teachers in school-based technology innovations: A typology of their beliefs on teaching and technology. *Computers & Education*, *114*, 57–68. doi:10.1016/j.compedu.2017.06.013

Afshari, M., Bakar, K. A., Luan, W. S., Samah, B. A., & Fooi, F. S. (2009). Factors affecting teachers' use of information and communication technology. *International Journal of Instructional Media*, *2*(1), 77–104.

Alberta Education. (2012). *Bring your own device: A guide for schools*. Edmonton, AB: Author. Retrieved from https://open.alberta.ca/dataset/5821955f-5809-4768-9fc8-3b81b78257f7/resource/631bf34c-d3e6-4648-ab77-2b36727dca0b/download/5783885-2012-07-Bring-your-own-device-a-guide-for-schools.pdf

Alenezi, A. (2017). Obstacles for teachers to integrate technology with instruction. *Education and Information Technologies*, *22*, 1797–1816. doi:10.1007/s10639-016-9518-5

Anderson, S. E., & Maninger, R. M. (2007). Preservice teachers' abilities, beliefs, and intentions regarding technology integration. *Journal of Educational Computing Research*, *37*(2), 151–172.

Arnold, P. L. (2015). *Rural high school faculty perspectives on bring your own device implementation: A phenomenological study.* (Doctoral dissertation). Liberty University, Lynchburg, VA.

Baker, R. (2013). *Rachel Baker introduces q methodology*. Glasgow Caledonian University, Glasgow, Scotland. Retrieved from https://videos.files.wordpress.com/nY7iR0Sv/rachelcaledonian-large-540p-video-sharing_dvd.mp4

Bandura, A. (1990). Perceived self-efficacy in the exercise of personal agency. *Revista Española de Pedagogía*, *48*(187), 397–427.

Bebell, D., & Kay, R. (2010). One to One Computing: A summary of the quantitative results from the Berkshire wireless learning initiative. *The Journal of Technology, Learning and Assessment*, *9*(2), 1–60.

Bigum, C. (1997). Teachers and computers: In control or being controlled? *Australian Journal of Education*, *41*, 247–261. doi: 10.1177/000494419704100304

Blocher, J. M., Armfield, S. W., Sujo–Montes, L., Tucker, G., & Willis, E. (2011). Contextually based professional development. *Computers in the Schools*, *28*, 158–169. doi: 10.1080/07380569.2011.577398

Brown, S. R. (1980). *Applications of q methodology in political science*. New Haven, CT and London, England: Yale University Press.

Brown, S. R. (1993). A primer on q methodology. *Operant Subjectivity*, *16*(3/4), 91-138.

Brown, S. R. (2017). *Q Methodology*. Retrieved from https://qmethodblog.files.wordpress.com/2017/09/brown-syllabus-2017.pdf

Burns-Sardone, N. (2014). Making the case for BYOD instruction in teacher education. *Issues in Informing Science and Information Technology*, *11*(1), 192–200.

Cavanagh., S. (2015). Districts turn "BYOD" disorder to their advantage. *Education Week*. Retrieved from https://www.edweek.org/ew/articles/2015/06/11/districts-turn-byod-disorder-to-their advantage.html?r=1805367146&qs=left+to+their+owned+devices

Center for Education Policy and Law. (2011). *Suggested school district policy on student misuse of electronic communication devices.* Retrieved from https://www.sandiego.edu/soles/documents/ECDSchoolPolicyforWebsite9-2-11.pdf

Charles, A. S. (2012). Cell phones: Rule-setting, rule-breaking, and relationships in classrooms. *American Secondary Education*, *40*(3), 4–16.

Chen, B. (2015). Exploring the digital divide: The use of digital technologies in Ontario Public Schools. *Canadian Journal of Learning & Technology*, *41*(3), 1–23.

Chen, C. (2008). Why do teachers not practice what they believe regarding technology integration? *The Journal of Educational Research*, *102*, 65–75. doi:10.3200/JOER.102.1.65-75

Cheng, G., Guan, Y., & Chau, J. (2016). An empirical study towards understanding user acceptance of bring your own device (BYOD) in higher education. *Australasian Journal of Educational Technology*, *32*(4), 1–17.

Chernoff, M. A. (2018). One-to-one or slim to none: New Jersey's chances of affording a one-to-one educational initiative. *Rutgers Computer & Tech. L. J. 44*(125), 1-28.

Chou, P., Chang, C., & Lin, C. (2017). BYOD or not: A comparison of two assessment strategies for student learning. *Computers in Human Behavior*, *74*, 63–71. doi:10.1016/j.chb.2017.04.024

Christensen, R., & Knezek, G. (2017). Readiness for integrating mobile learning in the classroom: Challenges, preferences and possibilities. *Computers in Human Behavior*, *76*, 112–121. doi:10.1016/j.chb.2017.07.014

Cochrane, T., Antonczak, L., Keegan, H., & Narayan, V. (2014). Riding the wave of BYOD: Developing a framework for creative pedagogies. *Research in Learning Technology*, *22*, 1–14. doi:10.3402/rlt.v22.24637

Consortium for School Networking. (2015). CoSN's framework of essential skills of the k-12 cto. Retrieved from https://cosn.org/sites/default/files/pdf/Framework_111815_2015_Public.pdf

Consortium for School Networking. (2017). 2017 K-12 IT leadership survey report. Author. Retrieved from http://www.cosn.org/sites/default/files/CoSN_IT_Ldrship_Report_2017_040317.pdf

Consortium for School Networking. (2018). 2018 K-12 IT leadership survey report. Retrieved from https://cosn.org/sites/default/files/final%20IT%20Leadership%202018.pdf

Conte, C. (1998). Technology in schools: Hip or hype? *Education Digest*, *63*(5), 28.

Cristol, D., & Gimbert, B. (2014). Academic achievement in BYOD classrooms. *Journal of Applied Learning Technology*, *4*, 24–30. doi:10.5339/qproc.2013.mlearn.15

Crompton, H., Burke, D., & Gregory, K. H. (2017). The use of mobile learning in PK-12 education: A systematic review. *Computers & Education*, *110*, 51–63. doi:10.1016/j.compedu.2017.03.013

Cuban, L. (1986). *Teachers and machines: The classroom use of technology since 1920.* New York, NY: Teachers College Press.

Cuban, L. (2006). The laptop revolution has no clothes. Retrieved from https://www.edweek.org/ew/articles/2006/10/18/08cuban.h26.html?cmp=SOC-SHR-FB

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal*, *38*(4), 813–834.

Culp, K. M., Honey, M., & Mandinach, E. (2005). A retrospective on twenty years of education technology policy. *Journal of Educational Computing Research*, *32*(3), 297–307.

Dafoe, A. (2015). On technological determinism: A typology, scope conditions, and a mechanism. *Science, Technology & Human Values*, *40*, 1047–1076. doi: 10.1177/0162243915579283

Dawson, C., & Rakes, G. C. (2003). The influence of principals' technology training on the integration of technology into schools. *Journal of Research on Technology in Education*, *36*(1), 29–49.

Dede, C. (2010). Comparing frameworks for 21st Century skills. In J. A. Bellanca (Ed.), *21st Century skills: Rethinking how students learn* (pp. 51–76). Bloomington, IN: Solution Tree Press.

de la Cruz Paragas, F., & Lin, T. T. C. (2016). Organizing and reframing technological determinism. *New Media & Society*, *18*, 1528–1546. doi:10.1177/1461444 814562156

Downer, K., & Bhattacharya, M. (2015). BYOD Security: A new business challenge. In *2015 IEEE International Conference on Smart City/SocialCom/SustainCom (SmartCity)* (pp.1128–1133). ieeexplore.ieee.org. doi:10.1109/SmartCity.2015. 221

EdTechXGlobal. (2016). Global report predicts edtech spend to reach $252bn by 2020. Retrieved from https://www.prnewswire.com/news-releases/global-report-predicts-edtech-spend-to-reach-252bn-by-2020-580765301.html

Edwards, A. (2012). *New technology and education*. New York, NY: Continuum International Publishing Group.

Ertmer, P. A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development: ETR & D*, *47*(4), 47–61.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research & Development*, *53*(4), 25-39.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, *42*, 255–284. doi:10.1080/15391523.2010.10782551

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, *59*, 423–435. doi: 10.1016/j.compedu.2012.02.001

Ertmer, P. A., Ottenbreit-Leftwich, A., & York, C. S. (2007). Exemplary technology-using teachers: Perceptions of factors influencing success. *Journal of Computing in Teacher Education*, *23*(2), 55–61.

Federal Communications Commission. (2017*). FAQs on e-rate program for schools and libraries*. Retrieved from https://www.fcc.gov/consumers/guides/universal-service-program-schools-and-libraries-e-rate

Field, A. P. (2015). *Discovering statistics using IBM SPSS statistics*. Los Angeles, CA: SAGE.

Fisher, T. (2006). Educational transformation: Is it, like “beauty”, in the eye of the beholder, or will we know it when we see it? *Education and Information Technologies*, *11*, 293–303. doi:10.1007/s10639-006-9009-1

Fox, C., Waters, J., Fletcher, G., & Levin, D. (2012). *The broadband imperative: Recommendations to address K-12 education infrastructure needs*. Glen Burnie, MD: State Educational Technology Directors Association.

Frank, K. A., Zhao, Y., & Borman, K. (2004). Social capital and the diffusion of innovations within organizations: The case of computer technology in schools. *Sociology of Education*, *2*, 148.

Garcia, A., & Abrego, C. (2014). Vital skills of the elementary principal as a technology leader. *E Journal of Organizational Learning & Leadership*, *12*(1), 12–25.

Gerald, W. B. (2003). April foolishness: The 20th anniversary of “A nation at risk.” *The Phi Delta Kappan*, *8*, 616.

Gil-Flores, J., Rodríguez-Santero, J., & Torres-Gordillo, J. J. (2017). Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure. *Computers in Human Behavior*, *68*, 441–449. doi:10.1016/j.chb.2016.11.057

Gillies, C. G. M. (2016). To BYOD or not to BYOD: Factors affecting academic acceptance of student mobile devices in the classroom. *Research in Learning Technology*, *24*(0), 1-16.

Glassett, K. F. (2007). Technology and pedagogical beliefs of teachers: A cross case [*sic*] analysis. In *Proceedings of the IADIS international conference on cognition & exploratory learning in digital age* (pp. 393–396). The University of Utah, Salt Lake City, UT.

Graham, E. (2013). "A nation at risk" turns 30: Where did it take us? - *NEA Today*. Retrieved from http://neatoday.org/2013/04/25/a-nation-at-risk-turns-30-where-did-it-take-us-2/

Grant, M., Tamim, S., Brown, D., Sweeney, J., Ferguson, F., & Jones, L. (2015). Teaching and learning with mobile computing devices: Case study in PREK-12 classrooms. *Techtrends: Linking Research & Practice to Improve Learning*, *59*, 32–45. doi:/10.1007/s11528015-0869-3

Gray, L., Thomas, N., & Lewis, L. (2010). *Teachers' use of educational technology in U.S. public schools: 2009*. National Center for Education Statistics. Retrieved from https://nces.ed.gov/pubs2010/2010040.pdf

Greenlaw, J. (2015). Deconstructing the metanarrative of the 21st Century skills movement. *Educational Philosophy and Theory*, *47*, 894–903. doi:10.1080/00131857.2015.1035156

Grogan, M. (Ed.). *The Jossey-Bass reader on educational leadership* (3rd ed.). (2013). San Francisco, CA: Jossey-Bass.

Gunn, T. M., & Hollingsworth, M. (2013). The implementation and assessment of a shared 21st Century learning vision: A district-based approach. *Journal Of Research On Technology In Education (International Society For Technology In Education)*, *45*(3), 201-228.

Gurley, D., Peters, G., Collins, L., & Fifolt, M. (2015). Mission, vision, values, and goals: An exploration of key organizational statements and daily practice in schools. *Journal of Educational Change*, *16*, 217-242. doi:10.1007/s10833-014-9229-x

Hall, D. (2008). *The technology director's guide to leadership: The power of great questions*. Eugene, OR: International Society for Technology in Education.

Hamilton, E. R., Rosenberg, J. M., & Akcaoglu, M. (2016). The substitution augmentation modification redefinition (SAMR) model: A critical review and suggestions for its use. *TechTrends*, *60*, 433–441. Retrieved from https://doi.org/10.1007/s11528-016-0091-y

Harkins, M. (2013). Mobile: Learn from Intel's CISO on securing employee-owned devices. Retrieved from http://www.govinfosecurity.com/webinars/mobile-learn-from-intels-ciso-on-securing-employee-owned-devices-w-264

Heifetz, R. A. (1994). *Leadership without easy answers*. Cambridge, MA: Harvard University Press.

Hermans, R., Tondeur, J., van Braak, J., & Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers & Education*, *51*, 1499–1509. doi:10.1016/j.compedu.2008.02.001

Herrington, N., & Coogan, J. (2011). Q methodology: an overview. *Research in Secondary Teacher Education*, *1*(2), 24–28. Retrieved from http://roar.uel.ac.uk/1414/1/2046-1240_1-2_pp24-28.pdf

Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research and Development: ETR & D*, *55*, 223–252. doi:10.1007/s11423006-9022-5

Hopkins, N., Sylvester, A., & Tate, M. (2013). Motivations for BYOD: An investigation of the contents of the 21st Century school bag. In *Proceedings of the 21st European conference on information systems (ECIS 2013)* (Number 183). Utrecht, The Netherlands: AIS Electronic Library (AISeL). Retrieved from https://eprints.qut.edu.au/114793/1/114793.pdf

Hsu, P.-S. (2016). Examining current beliefs, practices and barriers about technology integration: A case study. *TechTrends*, *60*, 30–40. doi:10.1007/s11528-015-0014-3

Hur, J. W., Shannon, D., & Wolf, S. (2016). An investigation of relationships between internal and external factors affecting technology integration in classrooms. *Journal of Digital Learning in Teacher Education*, *32*, 105–114. doi: 10.1080/21532974.2016.1169959

Hurston, A. L. (2017). *High schools implementing bring your own technology: A phenomenological study of classroom teacher's perspectives* (Doctoral dissertation). Liberty University, Lynchburg, VA.

Inan, F. A., & Lowther, D. L. (2010). Factors affecting technology integration in K-12 classrooms: A path model. *Educational Technology Research and Development: ETR & D*, *58*, 137–154. doi: 10.1007/s11423-009-9132-y

International Society for Technology in Education. (2009). *ISTE standards for administrators, 2009*. Eugene, OR: International Society for Technology in Education.

International Society for Technology in Education. (2016). ISTE Standards for Students Eugene, OR: International Society for Technology in Education. Retrieved from https://www.iste.org/standards/for-students

International Society for Technology in Education. ISTE Standards Essential Conditions. (2018). Retrieved from https://www.iste.org/standards/essential-conditions

International Society for Technology in Education. ISTE Technical Support. (2018). Retrieved from https://www.iste.org/standards/essential-conditions/technical-support

International Telecommunication Union. (2017). ICT Facts and Figures 2017. Retrieved from https://www.itu.int/en/ITU-D/Statistics/Pages/facts/default.aspx

James, W. (1884). *The dilemma of determinism*. Whitefish, MT: Kessinger Publishing. Retrieved from https://mypages.valdosta.edu/asantas/Texts/Dilemma_of_Determinism.pdf

Janssen, K. C., & Phillipson, S. (2015). Are we ready for BYOD? A systematic review of the implementation and communication of BYOD programs in Australian schools. *Australian Educational Computing*, *30*(2).

Jones, A., & Bissell, C. (2011). The social construction of educational technology through the use of authentic software tools. *Research in Learning Technology*, *19*. doi: 10.1080/21567069.2011.624995

K-12 Cyber Incident Map – K-12 Cybersecurity Resource Center. (2018). Retrieved December 3, 2018, from https://k12cybersecure.com/map/

Kereluik, K., Mishra, P., Fahnoe, C., & Terry, L. (2013). What knowledge is of most worth: Teacher knowledge for 21st Century learning. *Journal of Digital Learning in Teacher Education*, *29*(4), 127–140.

Kiger, D., & Herro, D. (2015). Bring your own device: Parental guidance (PG) suggested. *Techtrends: Linking Research & Practice to Improve Learning*, *59*, 51–61. doi: /10.1007/s11528-015-0891-5

Kim, C., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, *29*, 76–85. doi:10.1016/j.tate.2012.08.005

Klein, H. K., & Kleinman, D. L. (2002). The social construction of technology: Structural considerations. *Science, Technology & Human Values*, *27*(1), 28–52.

Koehler, M. J., Mishra, P., & Cain, W. (2013). What is technological pedagogical content knowledge (TPACK)? *The Journal of Educational Research*, *193*(3), 13–19.

Lacey, K. (2014). BYOD success story. *District Administration*, *50*(6), 83–87.

Lapek, J. (2017). 21st Century skills: The tools students need. *Children's Technology & Engineering*, *21*(3), 24–26.

Lee, Y., & Lee, J. (2014). Enhancing pre-service teachers' self-efficacy beliefs for technology integration through lesson planning practice. *Computers & Education*, *73*, 121–128. doi: 10.1016/j.compedu.2014.01.001

Levin, B. B., & Schrum, L. (2012). *Leading technology-rich schools: Award-winning models for success*. New York, NY: Teachers College Press.

Levin, T., & Wadmany, R. (2008). Teachers' views on factors affecting effective integration of information technology in the classroom: Developmental scenery. *Journal of Technology and Teacher Education*, *16*(2), 233–263.

Li, Q. (2014). Student and teacher views about technology: A tale of two cities? *Journal of Research on Technology in Education. 39*(4), 377–397.

Liu, S.-H. (2011). Factors related to pedagogical beliefs of teachers and technology integration. *Computers & Education*, *56*, 1012–1022. doi:10.1016/j.compedu.2010.12.001

Makki, T. W., O'Neal, L. J., Cotten, S. R., & Rikard, R. V. (2018). When first-order barriers are high: A comparison of second- and third-order barriers to classroom computing integration. *Computers & Education*, *120*, 90–97. doi:10.1016/j.compedu.2018.01.005

Maxwell, J. A. (2012). *Qualitative research design: An interactive approach* (Vol. 41). Thousand Oaks, CA: Sage Publications.

McKeown, B., & Thomas, D. B. (2013). *Q methodology* (Vol. 66). Los Angeles, CA: Sage.

McLean, K. J. (2016). The implementation of bring your own device (BYOD) in primary [elementary] schools. *Frontiers in Psychology*, *7*, 1739. doi:10.3389/fpsyg.2016.01739

Merga, M. K. (2015). "Bring your own device": Considering potential risks to student health. *Health Education Journal*, *75*, 464–473. doi:10.1177/0017896915599563

National Center for Education Statistics. (2017). *Children's access to and use of the Internet*. U.S. Department of Education. Retrieved from https://nces.ed.gov/programs/coe/pdf/coe_cch.pdf

National Commission on Excellence in Education. (1983). A nation at risk: The imperative for educational reform. *The Elementary School Journal*, *84*(2), 112–130.

National School Lunch Program Reports. (2018). Retrieved from https://www.education.pa.gov/Teachers%20-%20Administrators/Food-Nutrition/Pages/National-School-Lunch-Program-Reports.aspx

Nelson, D. (2012). BYOD: An opportunity schools cannot afford to miss. *Internet @ Schools*, *19*(5), 12–15

Ohio Department of Education. (2017). Ohio's Learning Standards for Technology. Retrieved from http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Technology/Ohio-s-2003-Academic-Content-Standards-in-Technolo/The-2017-Ohio-Learning-Standards-in-Technology.pdf.aspx

Oliver, M. (2011). Technological determinism in educational technology research: Some alternative ways of thinking about the relationship between learning and technology: Educational technology and determinism. *Journal of Computer Assisted Learning*, *27*, 373–384. doi: 10.1111/j.1365-2729.2011.00406.x

O'Sullivan-Donnell, B. (2013). *Student's personal mobile devices in the classroom: A case study of a BYOT district.* (Doctoral dissertation). Northeastern University, Boston, MA.

Pannabecker, J. R. (1991). Technological impacts and determinism in technology education: Alternate metaphors from social constructivism. *Journal of Technology Education*, *3*(1), 43–54. Retrieved from https://scholar.lib.vt.edu/ejournals/ JTE/v3n1/pannabecker.pdf

Partnership for 21st Century Learning. (2007). Framework for 21st Century learning. Retrieved from http://www.p21.org/storage/documents/docs/P21_framework_0816.pdf

Partnership for 21st Century Learning. (2018). Our history - P21. Retrieved from http://www.p21.org/about-us/our-history

Parsons, D., & Adhikari, J. (2016). Bring your own device to secondary school: The perceptions of teachers, students and parents. *Electronic Journal of E-Learning*, *14*(1), 66–79.

Pascopella, A. (2009). Why teachers must go mobile: A former teacher turned mobile phone expert encourages teachers to use cell phones in lessons, (MOBILE LEARNING GUIDE). *District Administration*, *10*(42), 42.

Pegrum, M., Oakley, G., & Faulkner, R. (2013). Schools going mobile: A study of the adoption of mobile handheld technologies in Western Australian independent schools. *Australasian Journal of Educational Technology*, *29*, 66–81. doi:10.14742/ ajet.64

Pennsylvania Association of Intermediate Units. (2014-2018). Retrieved from https://www.paiu.org/paiu.php

Pennsylvania Department of Education. (2002). Academic Standards for Science and Technology. Retrieved from https://www.education.pa.gov/Documents/Teachers-Administrators/Curriculum/Technology%20Education/ScienceandTechnologyStandards.pdf

Penuel, W. R. (2006). Implementation and effects of one-to-one computing initiatives: A research synthesis. *Journal of Research on Technology in Education*, *38*(3), 329–348

Petko, D. (2012). Teachers' pedagogical beliefs and their use of digital media in classrooms: Sharpening the focus of the "will, skill, tool" model and integrating teachers' constructivist orientations. *Computers & Education*, *58*, 1351–1359. doi:10.1016/j.compedu.2011.12.013

Pinch, T. J., & Bijker, W. E. (1984). The social construction of facts and artefacts: Or how the sociology of science and the sociology of technology might benefit each other. *Social Studies of Science*, *14*, 399–441. doi: 10.1177/0306312840 14003004

Prestridge, S. (2012). The beliefs behind the teacher that influences their ICT practices. *Computers & Education*, *58*, 449–458. doi:10.1016/j.compedu.2011.08.028

Project Tomorrow. (2012). Schools' education technology budgets shrink as need and demand grows. Retrieved from http://www.tomorrow.org/speakup/pr/SpeakUp 2012AprilReleaseFINAL.pdf

Quillen, I. (2010). Schools open doors to students' mobile devices. *Digital Directions*, 30–35.

Quillen, I. (2011). Districts tackle questions surrounding BYOD policy. *Digital Directions*, 22-23.

Ravitch, D. (2010). A century of skills movements. *American Educator*, *34*(1), 12–13.

Riggs, D. (2018). Education technology is a global opportunity. *TechCrunch*. Retrieved from http://social.techcrunch.com/2018/01/19/education-technology-is-a-global-opportunity/

Rotherham, A. J., & Willingham, D. (2009). To work, the 21st Century skills movement will require keen attention to curriculum, teacher quality, and assessment. *Educational Leadership*, *67*(1), 16–21.

Said, G., & Stricklin, M. (2014). Dialogism: A philosophical contribution to understanding concourse and consciring. *Operant Subjectivity*, *37*, 21–37. doi:10.15133/j.os.2014.010

Salehan, M., Kim, D. J., & Lee, J.-N. (2018). Are there any relationships between technology and cultural values? A country-level trend study of the association between information communication technology and cultural values. *Information & Management*, *55*, 725-745. doi: 10.1016/j.im.2018.03.003

Santos, I. M., Bocheco, O., & Habak, C. (2018). A survey of student and instructor perceptions of personal mobile technology usage and policies for the classroom. *Education and Information Technologies*, *23*, 617–632. doi: 10.1007/s10639-017-9625-y

Schaffhauser, D. (2016). Report: Education tech spending on the rise. Retrieved from https://thejournal.com/articles/2016/01/19/report-education-tech-spending-on-the-rise.aspx

Schmolck, P. (2014). *PQManual*. Retrieved from http://schmolck.org/qmethod/pqmanual.htm

Selwyn, N. (2012). Making sense of young people, education and digital technology: The role of sociological theory. *Oxford Review of Education*, *38*, 81–96. doi: 10.1080/03054985.2011.577949

Selwyn, N., & Bulfin, S. (2016). Exploring school regulation of students' technology use – Rules that are made to be broken? *Educational Review*, *68*, 274–290. doi:10.1080/00131911.2015.1090401

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Belmont, CA: Wadsworth Cengage Learning.

Shin, W. S., Han, I., & Kim, I. (2014). Teachers' technology use and the change of their pedagogical beliefs in Korean educational context. *International Education Studies, 7*, 11–22. doi:10.5539/ies.v7n8p11

Siltanen, R. (2011, December 14). The real story behind Apple's "think different" campaign [Online forum comment]. Retrieved from https://www.forbes.com/sites/onmarketing/ 2011/12/14/the-real-story-behind-apples-think-different-campaign/

Smith, M. R., & Marx, L. (1994). *Does technology drive history?: The dilemma of technological determinism*. Cambridge, MA: MIT Press.

Söderberg, J. (2013). Determining social change: The role of technological determinism in the collective action framing of hackers. *New Media & Society*, *15*, 1277–1293. doi: 10.1177/1461444812470093

Song, Y. (2014). Bring your own device (BYOD) for seamless science inquiry in a primary school. *Computers & Education*, *74*, 50–60. doi:10.1016/j.compedu.2014.01.005

Stager, G. (2007). Refreshing the ISTE technology standards: Senior editor Gary Stager interviews Don Knezek, CEO of ISTE, on the revised national educational technology standards (NETS). Retrieved from https://www.questia.com/magazine/1G1-164871503/refreshing-the-iste-technology-standards-senior-editor

STEM for All. (2016). Retrieved from https://obamawhitehouse.archives.gov/blog/2016/02/11/stem-all

Tamim, R., Bernard, R., Borokhovski, E., Abrami, P., & Schmid, R. (2011). What forty years of research says about the impact of technology on learning: A second-order meta-analysis and validation study. *Review of Educational Research, 81*(1), 4-28.

Thomas, K., & Munoz, M. (2016). Hold the phone! High school students' perceptions of mobile phone integration in the classroom. *American Secondary Education*, *44*(3), 19–37.

Thompson, G. (2017). 3 keys to a successful 1-to-1 and BYOD implementation. *THE Journal*, *44*(5), 14.

Tondeur, J., van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: A systematic review of qualitative evidence. *Educational Technology Research and Development: ETR & D*, *65*, 555–575. doi: 10.1007/s11423-016-9481-2

Traxler, J. (2010). Students and mobile devices. *ALT-J*, *18*, 149–160. doi: 10.1080/09687769.2010.492847

Traxler, J. (2016). Inclusion in an age of mobility. *Research in Learning Technology*, *24*, 1-18. doi:10.3402/rlt.v24.31372

Typology of Ohio School Districts | Ohio Department of Education. (2015) Retrieved from http://education.ohio.gov/Topics/Data/Report-Card-Resources/Report-Card-Data-Forms-and-Information/Typology-of-Ohio-School-Districts

U.S. Department of Education. (2009). *Evaluation of the enhancing education through technology program: Final report -- May 2009* (PDF). U.S. Department of Education. Retrieved from https://www2.ed.gov/rschstat/eval/tech/netts/finalreport.pdf

van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior*, *72*, 577–588. doi:10.1016/j.chb.2017.03.010

Vongkulluksn, V. W., Xie, K., & Bowman, M. A. (2018). The role of value on teachers' internalization of external barriers and externalization of personal beliefs for classroom technology integration. *Computers & Education*, *118*, 70–81. doi:/10.1016/j.compedu.2017.11.009

Watts, S., & Stenner, P. (2005). Doing q methodology: Theory, method and interpretation. *Qualitative Research in Psychology*, *2*(1), 67-91.

Watts, S., & Stenner, P. (2012). *Doing q methodological research: Theory, method & interpretation*. Thousand Oaks, CA: Sage.

Waxman, H. C., Boriack, A. W., Lee, Y. H., & MacNeil, A. (2013). Principals' perceptions of the importance of technology in schools. *Educational Technology Research and Development: ETR & D*, *4*(3), 187–196.

Webster, M. D. (2017). Philosophy of technology assumptions in educational technology leadership. *Journal of Educational Technology & Society*, *20*(1), 25–36.

Weinstock, J. (2010). Left to their own devices: With cost concerns squeezing districts out of 1-to-1 computing programs, a once unthinkable solution is now in play: Allowing students to bring their own laptops, PDAs, and--heaven help us--cell phones. *T H E Journal*, *1*(32).

Wellington, J., & Szczerbinski, M. (2007). *Research methods for the social sciences*. New York, NY: Continuum International Publishing.

Weston, M. E., & Bain, A. (2010). The end of techno-critique: The naked truth about 1:1 laptop initiatives and educational change. *The Journal of Technology, Learning and Assessment*, *9*(6), 1-25.

Williams, N. L., & Larwin, K. H. (2016). One-to-one computing and student achievement in Ohio high schools. *Journal of Research on Technology in Education*, *48*, 143–158. doi:10.1080/15391523.2016.1175857

Winterhalder, J. E. (2017). *Teachers' perceptions and experiences in implementing mobile devices into their teaching.* (Doctoral dissertation). Walden University, Minneapolis, MN.

Woodside, J. M., & Sharam, A. (2014). Bring your own technology (BYOT) to education. *Journal of Systemics, Cybernetics and Informatics*, *12*(3), 38–40.

Wozney, L., Venkatesh, V., & Abrami, P. (2006). Implementing computer technologies: Teachers' perceptions and practices. *Journal of Technology and Teacher Education*, *14*(1), 173–207.

Yousefikhah, S. (2017). Sociology of innovation: Social construction of technology perspective. *AD-Minister*, *30*, 31–43. doi: 10.17230/ad-minister.30.2

Yuan-Hsuan Lee, J., Waxman, H., Jiun-Yu Wu, J., Michko, G., & Lin, G. (2013). Revisit the effect of teaching and learning with technology. *Journal of Educational Technology & Society*, *16*(1), 133-146.

Zimmerman, B. J., Schunk, D. H., & DiBenedetto, M. K. (2017). The role of self-efficacy and related beliefs in self-regulation of learning performance. In A. J. Elliot, C. S. Dweck, & D. S. Yeager (Eds.), *Handbook of competence and motivation* (2nd ed., p. 313). New York, NY: Guilford Publications.

APPENDIX A

Q-Sort Grid

34 Statement Q-Sort **Researcher** **Sorter** Date

Disagree Most Agree Most

1	2	3	4	5	6	7	8	9

Topic: **BYOD**

IDCODE:

APPENDIX B

Full Q-Sort Analysis

Path and Project Name: C:\Users\khlarwin\Desktop\PQMethod/BYOD_PZ Mar 14 19

Correlation Matrix Between Sorts

SORTS	1	2	3	4	5	6	7	8	9	10	11	12	13
1 01fs39	100	42	16	3	-6	50	20	-19	21	18	56	-2	-5
2 02ms11	42	100	51	27	25	52	17	-1	31	8	61	19	25
3 03mu49	16	51	100	37	28	56	7	-9	46	21	41	19	26
4 04FS15	3	27	37	100	16	20	21	24	12	-16	22	29	25
5 05ms10	-6	25	28	16	100	31	10	61	39	18	16	-3	24
6 06ms49	50	52	56	20	31	100	40	11	47	12	46	11	31
7 07ms12	20	17	7	21	10	40	100	18	12	32	33	44	18
8 08ms07	-19	-1	-9	24	61	11	18	100	13	-4	-1	8	30
9 09mr48	21	31	46	12	39	47	12	13	100	18	33	36	61
10 10fr39	18	8	21	-16	18	12	32	-4	18	100	0	27	26
11 11ms21	56	61	41	22	16	46	33	-1	33	0	100	29	9
12 12ft34	-2	19	19	29	-3	11	44	8	36	27	29	100	26
13 13mt47	-5	25	26	25	24	31	18	30	61	26	9	26	100

Unrotated Factor Matrix

	Factors							
	1	2	3	4	5	6	7	8
SORTS								
1 01fs39	0.4600	-0.6465	-0.0267	-0.1355	0.3304	-0.1961	-0.1073	0.2117
2 02ms11	0.7078	-0.2978	-0.2456	0.0491	-0.0302	0.0967	0.1634	0.3054
3 03mu49	0.6866	-0.1089	-0.2074	-0.0993	-0.4065	0.4352	-0.0414	-0.2016
4 04FS15	0.4350	0.1932	-0.1769	0.6616	-0.2303	0.2034	-0.2669	0.2002
5 05ms10	0.4626	0.5539	-0.3571	-0.2317	0.3311	0.2378	0.2277	-0.0624
6 06ms49	0.7722	-0.1751	-0.1551	-0.1306	0.1588	-0.0514	-0.3520	-0.3064
7 07ms12	0.4840	0.0294	0.5465	0.3041	0.4342	0.0266	-0.2269	-0.1954
8 08ms07	0.2236	0.7473	-0.2026	0.1592	0.4489	-0.0951	0.0513	0.0873
9 09mr48	0.6956	0.2076	0.0029	-0.3246	-0.2974	-0.3657	0.1316	-0.1874
10 10fr39	0.3050	0.0691	0.6232	-0.5017	0.1106	0.4058	-0.0061	0.2457
11 11ms21	0.6833	-0.4160	-0.0979	0.2175	0.1593	-0.1303	0.3461	0.0300
12 12ft34	0.4527	0.1347	0.6104	0.3735	-0.2276	-0.0541	0.3500	-0.0948
13 13mt47	0.5409	0.4701	0.1288	-0.1953	-0.3149	-0.3390	-0.2619	0.2887
Eigenvalues	4.0090	1.9127	1.4138	1.2388	1.1302	0.7808	0.6693	0.5510
% expl.Var.	31	15	11	10	9	6	5	4

Cumulative Communalities Matrix

Factors 1 Thru ....

SORTS	1	2	3	4	5	6	7	8
1 01fs39	0.2116	0.6296	0.6303	0.6486	0.7578	0.7962	0.8077	0.8525
2 02ms11	0.5010	0.5897	0.6500	0.6524	0.6533	0.6627	0.6894	0.7826
3 03mu49	0.4714	0.4832	0.5262	0.5361	0.7013	0.8907	0.8924	0.9331
4 04FS15	0.1892	0.2265	0.2578	0.6955	0.7485	0.7899	0.8612	0.9012
5 05ms10	0.2140	0.5208	0.6483	0.7020	0.8116	0.8682	0.9200	0.9239
6 06ms49	0.5962	0.6269	0.6509	0.6680	0.6932	0.6958	0.8198	0.9136
7 07ms12	0.2342	0.2351	0.5338	0.6262	0.8147	0.8154	0.8669	0.9051
8 08ms07	0.0500	0.6085	0.6496	0.6749	0.8765	0.8855	0.8881	0.8958
9 09mr48	0.4838	0.5269	0.5269	0.6323	0.7207	0.8545	0.8718	0.9069
10 10fr39	0.0930	0.0978	0.4862	0.7378	0.7501	0.9148	0.9148	0.9752
11 11ms21	0.4669	0.6400	0.6495	0.6968	0.7222	0.7392	0.8590	0.8599
12 12ft34	0.2050	0.2231	0.5957	0.7352	0.7870	0.7900	0.9125	0.9215
13 13mt47	0.2925	0.5136	0.5302	0.5683	0.6675	0.7824	0.8510	0.9343
cum% expl.Var.	31	46	56	66	75	81	86	90

Factor Matrix with an X Indicating a Defining Sort Loadings

QSORT	1	2	3
1 01fs39	0.4600	-0.6465X	-0.0267
2 02ms11	0.7078X	-0.2978	-0.2456
3 03mu49	0.6866X	-0.1089	-0.2074
4 04FS15	0.4350X	0.1932	-0.1769
5 05ms10	0.4626	0.5539	-0.3571
6 06ms49	0.7722X	-0.1751	-0.1551
7 07ms12	0.4840	0.0294	0.5465X
8 08ms07	0.2236	0.7473X	-0.2026
9 09mr48	0.6956X	0.2076	0.0029
10 10fr39	0.3050	0.0691	0.6232X
11 11ms21	0.6833X	-0.4160	-0.0979
12 12ft34	0.4527	0.1347	0.6104X
13 13mt47	0.5409X	0.4701	0.1288
% expl.Var.	31	15	11

PQMethod2.35 BYOD_PZ PAGE 3

Path and Project Name: C:\Users\khlarwin\Desktop\PQMethod/BYOD_PZ Mar 14 19

Free Distribution Data Results

QSORT		MEAN	ST.DEV.
1	01fs39	0.000	2.202
2	02ms11	0.000	2.202
3	03mu49	0.000	2.202
4	04FS15	0.000	2.202
5	05ms10	0.000	2.202
6	06ms49	0.000	2.202
7	07ms12	0.000	2.202
8	08ms07	0.000	2.202
9	09mr48	0.000	2.202
10	10fr39	0.000	2.202
11	11ms21	0.000	2.202
12	12ft34	0.000	2.202
13	13mt47	0.000	2.202

PQMethod2.35 BYOD_PZ PAGE 4

Path and Project Name: C:\Users\khlarwin\Desktop\PQMethod/BYOD_PZ Mar 14 19

Factor Scores with Corresponding Ranks

			Factors					
No.	Statement	No.	1		2		3	
1	I am not for BYOD.	1	-1.39	33	0.92	8	-1.32	32
2	Excess bandwidth is due to all the non-academic applic	2	-1.02	28	1.51	3	-0.71	24
3	BYOD allows students to have opportunites to use devic	3	-0.99	27	-1.39	32	-1.04	31
4	BYOD devices will not support the higher end applicati	4	-1.34	31	-1.17	29	-0.96	28
5	With BYOD, students can use devices with which they ar	5	0.38	14	-0.00	18	1.60	3
6	Environments where every student has a device allows e	6	1.81	1	-0.93	27	-0.22	18
7	Teachers will have to interact with different devices.	7	-0.66	23	0.35	16	0.77	10
8	BYOD creates problems for teachers trying to get their	8	-0.56	22	1.28	4	1.03	7
9	It's much better for the school to provide consistent,	9	1.18	6	0.69	12	1.13	6
10	BYOD will increase cheating.	10	-1.36	32	-0.36	21	-1.62	34
11	Students will often forget to charge their devices.	11	-1.13	30	1.63	1	-0.80	25
12	I don't beleive there is a benefit to BYOD.	12	-1.77	34	0.57	14	-1.36	33
13	BYOD allows teachers to be more connected with student	13	-0.72	25	-1.63	34	-0.14	16
14	With BYOD, students can customize and use a device the	14	0.58	12	0.35	16	-0.48	22
15	A student's BYOD device is potentially a better device	15	-0.20	19	-0.23	19	0.78	9

16	BYOD allows instruction to become more student-centere	16	0.43	13	-1.27	30	-0.55	23
17	With BYOD, students can use devices they have setup to	17	0.28	15	-1.05	28	-0.10	15
18	BYOD could get technology into students' hands if you	18	0.67	10	1.17	5	-0.86	27
19	Student familiarity with her/his own device is importa	19	0.27	16	-0.93	27	0.94	8
20	Students have the opportunity to see how a variety of	20	-1.03	29	-0.81	25	-0.48	21
21	BYOD provides an opportunity for hacking.	21	-0.71	24	1.16	6	-0.24	19
22	Environments where every student has a device allows f	22	1.73	2	-0.46	22	0.23	14
23	Environments where every student has a device allows f	23	1.69	3	-0.81	25	0.27	13
24	BYOD results in so many random issues that a classroom	24	-0.33	20	0.11	17	0.54	11
25	BYOD puts your network in danger from all the malware	25	-0.51	21	1.51	3	-1.00	29
26	The increase in access to technology is key for studen	26	1.33	4	-0.57	23	-0.82	26
27	BYOD provides possible cost savings.	27	0.83	7	0.69	12	-1.02	30
28	BYOD allows students to bring their technology to thei	28	-0.05	17	-1.39	32	-0.43	20
29	The mix of BYOD devices in the classroom may conflict	29	-0.72	26	0.58	13	1.45	4
30	BYOD increases the percieved social pressure of the "h	30	0.73	9	0.93	7	1.30	5
31	Environments where every student has a device allow fo	31	1.19	5	-0.34	20	0.39	12
32	BYOD allows students the opportunity to leverage down	32	0.79	8	0.70	10	-0.16	17
33	BYOD gives the students unlimited access to informatio	33	-0.05	18	-1.51	33	1.70	2
34	Not all students can provide a BYOD device.	34	0.67	11	0.70	10	2.20	1

Correlations Between Factor Scores

	1	2	3
1	1.0000	-0.1528	0.3480
2	-0.1528	1.0000	-0.0109
3	0.3480	-0.0109	1.0000

Factor Scores -- For Factor 1

No.	Statement	No.	Z-SCORES
6	Environments where every student has a device allows expande	6	1.810
22	Environments where every student has a device allows for imp	22	1.729
23	Environments where every student has a device allows for enh	23	1.690
26	The increase in access to technology is key for students.	26	1.326
31	Environments where every student has a device allow for incr	31	1.187
9	It's much better for the school to provide consistent, relia	9	1.175
27	BYOD provides possible cost savings.	27	0.833
32	BYOD allows students the opportunity to leverage down time b	32	0.786
30	BYOD increases the percieved social pressure of the "haves v	30	0.732
18	BYOD could get technology into students' hands if you curren	18	0.668
34	Not all students can provide a BYOD device.	34	0.668
14	With BYOD, students can customize and use a device they have	14	0.577
16	BYOD allows instruction to become more student-centered.	16	0.432
5	With BYOD, students can use devices with which they are fami	5	0.383
17	With BYOD, students can use devices they have setup to their	17	0.276
19	Student familiarity with her/his own device is important.	19	0.272
28	BYOD allows students to bring their technology to their lear	28	-0.050
33	BYOD gives the students unlimited access to information and	33	-0.055
15	A student's BYOD device is potentially a better device than	15	-0.198
24	BYOD results in so many random issues that a classroom canno	24	-0.330
25	BYOD puts your network in danger from all the malware that s	25	-0.509
8	BYOD creates problems for teachers trying to get their instr	8	-0.560
7	Teachers will have to interact with different devices.	7	-0.657
21	BYOD provides an opportunity for hacking.	21	-0.711
13	BYOD allows teachers to be more connected with students and	13	-0.723
29	The mix of BYOD devices in the classroom may conflict with t	29	-0.723

3	BYOD allows students to have opportunites to use devices and	3	-0.988
2	Excess bandwidth is due to all the non-academic applications	2	-1.017
20	Students have the opportunity to see how a variety of device	20	-1.035
11	Students will often forget to charge their devices.	11	-1.125
4	BYOD devices will not support the higher end applications we	4	-1.337
10	BYOD will increase cheating.	10	-1.361
1	I am not for BYOD.	1	-1.392
12	I don't beleive there is a benefit to BYOD.	12	-1.771

Factor Scores -- For Factor 2

No.	Statement	No.	Z-SCORES
11	Students will often forget to charge their devices.	11	1.633
2	Excess bandwidth is due to all the non-academic applications	2	1.512
25	BYOD puts your network in danger from all the malware that s	25	1.512
8	BYOD creates problems for teachers trying to get their instr	8	1.282
18	BYOD could get technology into students' hands if you curren	18	1.173
21	BYOD provides an opportunity for hacking.	21	1.162
30	BYOD increases the percieved social pressure of the "haves v	30	0.932
1	I am not for BYOD.	1	0.921
32	BYOD allows students the opportunity to leverage down time b	32	0.701
34	Not all students can provide a BYOD device.	34	0.701
27	BYOD provides possible cost savings.	27	0.690
9	It's much better for the school to provide consistent, relia	9	0.690
29	The mix of BYOD devices in the classroom may conflict with t	29	0.581
12	I don't beleive there is a benefit to BYOD.	12	0.570
7	Teachers will have to interact with different devices.	7	0.351
14	With BYOD, students can customize and use a device they have	14	0.351
24	BYOD results in so many random issues that a classroom canno	24	0.110
5	With BYOD, students can use devices with which they are fami	5	-0.000
15	A student's BYOD device is potentially a better device than	15	-0.230
31	Environments where every student has a device allow for incr	31	-0.340
10	BYOD will increase cheating.	10	-0.362
22	Environments where every student has a device allows for imp	22	-0.460
26	The increase in access to technology is key for students.	26	-0.570
23	Environments where every student has a device allows for enh	23	-0.811
20	Students have the opportunity to see how a variety of device	20	-0.811
19	Student familiarity with her/his own device is important.	19	-0.932
6	Environments where every student has a device allows expande	6	-0.932

17	With BYOD, students can use devices they have setup to their	17	-1.052
4	BYOD devices will not support the higher end applications we	4	-1.173
16	BYOD allows instruction to become more student-centered.	16	-1.271
3	BYOD allows students to have opportunites to use devices and	3	-1.392
28	BYOD allows students to bring their technology to their lear	28	-1.392
33	BYOD gives the students unlimited access to information and	33	-1.512
13	BYOD allows teachers to be more connected with students and	13	-1.633

Factor Scores -- For Factor 3

No.	Statement	No.	Z-SCORES
34	Not all students can provide a BYOD device.	34	2.203
33	BYOD gives the students unlimited access to information and	33	1.702
5	With BYOD, students can use devices with which they are fami	5	1.597
29	The mix of BYOD devices in the classroom may conflict with t	29	1.446
30	BYOD increases the percieved social pressure of the "haves v	30	1.298
9	It's much better for the school to provide consistent, relia	9	1.128
8	BYOD creates problems for teachers trying to get their instr	8	1.033
19	Student familiarity with her/his own device is important.	19	0.938
15	A student's BYOD device is potentially a better device than	15	0.777
7	Teachers will have to interact with different devices.	7	0.767
24	BYOD results in so many random issues that a classroom canno	24	0.541
31	Environments where every student has a device allow for incr	31	0.394
23	Environments where every student has a device allows for enh	23	0.265
22	Environments where every student has a device allows for imp	22	0.233
17	With BYOD, students can use devices they have setup to their	17	-0.105
13	BYOD allows teachers to be more connected with students and	13	-0.141
32	BYOD allows students the opportunity to leverage down time b	32	-0.157
6	Environments where every student has a device allows expande	6	-0.223
21	BYOD provides an opportunity for hacking.	21	-0.243
28	BYOD allows students to bring their technology to their lear	28	-0.426
20	Students have the opportunity to see how a variety of device	20	-0.478
14	With BYOD, students can customize and use a device they have	14	-0.479
16	BYOD allows instruction to become more student-centered.	16	-0.554
2	Excess bandwidth is due to all the non-academic applications	2	-0.712
11	Students will often forget to charge their devices.	11	-0.800
26	The increase in access to technology is key for students.	26	-0.820
18	BYOD could get technology into students' hands if you curren	18	-0.862
4	BYOD devices will not support the higher end applications we	4	-0.958

25	BYOD puts your network in danger from all the malware that s	25	-1.000
27	BYOD provides possible cost savings.	27	-1.020
3	BYOD allows students to have opportunites to use devices and	3	-1.043
1	I am not for BYOD.	1	-1.321
12	I don't beleive there is a benefit to BYOD.	12	-1.364
10	BYOD will increase cheating.	10	-1.617

Descending Array of Differences Between Factors 1 and 2

No.	Statement	No.	Type 1	Type 2	Difference
6	Environments where every student has a device allows expande	6	1.810	-0.932	2.742
23	Environments where every student has a device allows for enh	23	1.690	-0.811	2.501
22	Environments where every student has a device allows for imp	22	1.729	-0.460	2.190
26	The increase in access to technology is key for students.	26	1.326	-0.570	1.896
16	BYOD allows instruction to become more student-centered.	16	0.432	-1.271	1.703
31	Environments where every student has a device allow for incr	31	1.187	-0.340	1.526
33	BYOD gives the students unlimited access to information and	33	-0.055	-1.512	1.457
28	BYOD allows students to bring their technology to their lear	28	-0.050	-1.392	1.342
17	With BYOD, students can use devices they have setup to their	17	0.276	-1.052	1.328
19	Student familiarity with her/his own device is important.	19	0.272	-0.932	1.204
13	BYOD allows teachers to be more connected with students and	13	-0.723	-1.633	0.910
9	It's much better for the school to provide consistent, relia	9	1.175	0.690	0.485
3	BYOD allows students to have opportunites to use devices and	3	-0.988	-1.392	0.404
5	With BYOD, students can use devices with which they are fami	5	0.383	-0.000	0.383
14	With BYOD, students can customize and use a device they have	14	0.577	0.351	0.227
27	BYOD provides possible cost savings.	27	0.833	0.690	0.142
32	BYOD allows students the opportunity to leverage down time b	32	0.786	0.701	0.084
15	A student's BYOD device is potentially a better device than	15	-0.198	-0.230	0.032
34	Not all students can provide a BYOD device.	34	0.668	0.701	-0.033
4	BYOD devices will not support the higher end applications we	4	-1.337	-1.173	-0.165
30	BYOD increases the percieved social pressure of the "haves v	30	0.732	0.932	-0.200
20	Students have the opportunity to see how a variety of device	20	-1.035	-0.811	-0.224
24	BYOD results in so many random issues that a classroom canno	24	-0.330	0.110	-0.440
18	BYOD could get technology into students' hands if you curren	18	0.668	1.173	-0.505
10	BYOD will increase cheating.	10	-1.361	-0.362	-0.999
7	Teachers will have to interact with different devices.	7	-0.657	0.351	-1.008
29	The mix of BYOD devices in the classroom may conflict with t	29	-0.723	0.581	-1.304
8	BYOD creates problems for teachers trying to get their instr	8	-0.560	1.282	-1.842
21	BYOD provides an opportunity for hacking.	21	-0.711	1.162	-1.872
25	BYOD puts your network in danger from all the malware that s	25	-0.509	1.512	-2.022

1	I am not for BYOD.	1	-1.392	0.921	-2.312
12	I don't beleive there is a benefit to BYOD.	12	-1.771	0.570	-2.341
2	Excess bandwidth is due to all the non-academic applications	2	-1.017	1.512	-2.530
11	Students will often forget to charge their devices.	11	-1.125	1.633	-2.758

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Descending Array of Differences Between Factors 1 and 3

No.	Statement	No.	Type 1	Type 3	Difference
26	The increase in access to technology is key for students.	26	1.326	-0.820	2.146
6	Environments where every student has a device allows expande	6	1.810	-0.223	2.033
27	BYOD provides possible cost savings.	27	0.833	-1.020	1.853
18	BYOD could get technology into students' hands if you curren	18	0.668	-0.862	1.530
22	Environments where every student has a device allows for imp	22	1.729	0.233	1.496
23	Environments where every student has a device allows for enh	23	1.690	0.265	1.425
14	With BYOD, students can customize and use a device they have	14	0.577	-0.479	1.057
16	BYOD allows instruction to become more student-centered.	16	0.432	-0.554	0.986
32	BYOD allows students the opportunity to leverage down time b	32	0.786	-0.157	0.943
31	Environments where every student has a device allow for incr	31	1.187	0.394	0.793
25	BYOD puts your network in danger from all the malware that s	25	-0.509	-1.000	0.491
17	With BYOD, students can use devices they have setup to their	17	0.276	-0.105	0.381
28	BYOD allows students to bring their technology to their lear	28	-0.050	-0.426	0.376
10	BYOD will increase cheating.	10	-1.361	-1.617	0.256
3	BYOD allows students to have opportunites to use devices and	3	-0.988	-1.043	0.054
9	It's much better for the school to provide consistent, relia	9	1.175	1.128	0.047
1	I am not for BYOD.	1	-1.392	-1.321	-0.070
2	Excess bandwidth is due to all the non-academic applications	2	-1.017	-0.712	-0.306
11	Students will often forget to charge their devices.	11	-1.125	-0.800	-0.326
4	BYOD devices will not support the higher end applications we	4	-1.337	-0.958	-0.380
12	I don't beleive there is a benefit to BYOD.	12	-1.771	-1.364	-0.407
21	BYOD provides an opportunity for hacking.	21	-0.711	-0.243	-0.468
20	Students have the opportunity to see how a variety of device	20	-1.035	-0.478	-0.556
30	BYOD increases the percieved social pressure of the "haves v	30	0.732	1.298	-0.566
13	BYOD allows teachers to be more connected with students and	13	-0.723	-0.141	-0.582
19	Student familiarity with her/his own device is important.	19	0.272	0.938	-0.666
24	BYOD results in so many random issues that a classroom canno	24	-0.330	0.541	-0.871
15	A student's BYOD device is potentially a better device than	15	-0.198	0.777	-0.976
5	With BYOD, students can use devices with which they are fami	5	0.383	1.597	-1.214
7	Teachers will have to interact with different devices.	7	-0.657	0.767	-1.424
34	Not all students can provide a BYOD device.	34	0.668	2.203	-1.535

8	BYOD creates problems for teachers trying to get their instr	8	-0.560	1.033	-1.593
33	BYOD gives the students unlimited access to information and	33	-0.055	1.702	-1.757
29	The mix of BYOD devices in the classroom may conflict with t	29	-0.723	1.446	-2.170

Descending Array of Differences Between Factors 2 and 3

No.	Statement	No.	Type 2	Type 3	Difference
25	BYOD puts your network in danger from all the malware that s	25	1.512	-1.000	2.513
11	Students will often forget to charge their devices.	11	1.633	-0.800	2.433
1	I am not for BYOD.	1	0.921	-1.321	2.242
2	Excess bandwidth is due to all the non-academic applications	2	1.512	-0.712	2.224
18	BYOD could get technology into students' hands if you curren	18	1.173	-0.862	2.035
12	I don't beleive there is a benefit to BYOD.	12	0.570	-1.364	1.934
27	BYOD provides possible cost savings.	27	0.690	-1.020	1.711
21	BYOD provides an opportunity for hacking.	21	1.162	-0.243	1.405
10	BYOD will increase cheating.	10	-0.362	-1.617	1.255
32	BYOD allows students the opportunity to leverage down time b	32	0.701	-0.157	0.859
14	With BYOD, students can customize and use a device they have	14	0.351	-0.479	0.830
26	The increase in access to technology is key for students.	26	-0.570	-0.820	0.250
8	BYOD creates problems for teachers trying to get their instr	8	1.282	1.033	0.250
4	BYOD devices will not support the higher end applications we	4	-1.173	-0.958	-0.215
20	Students have the opportunity to see how a variety of device	20	-0.811	-0.478	-0.333
3	BYOD allows students to have opportunites to use devices and	3	-1.392	-1.043	-0.349
30	BYOD increases the percieved social pressure of the "haves v	30	0.932	1.298	-0.366
7	Teachers will have to interact with different devices.	7	0.351	0.767	-0.416
24	BYOD results in so many random issues that a classroom canno	24	0.110	0.541	-0.431
9	It's much better for the school to provide consistent, relia	9	0.690	1.128	-0.438
22	Environments where every student has a device allows for imp	22	-0.460	0.233	-0.693
6	Environments where every student has a device allows expande	6	-0.932	-0.223	-0.709
16	BYOD allows instruction to become more student-centered.	16	-1.271	-0.554	-0.717
31	Environments where every student has a device allow for incr	31	-0.340	0.394	-0.733
29	The mix of BYOD devices in the classroom may conflict with t	29	0.581	1.446	-0.865
17	With BYOD, students can use devices they have setup to their	17	-1.052	-0.105	-0.947
28	BYOD allows students to bring their technology to their lear	28	-1.392	-0.426	-0.966
15	A student's BYOD device is potentially a better device than	15	-0.230	0.777	-1.007
23	Environments where every student has a device allows for enh	23	-0.811	0.265	-1.076
13	BYOD allows teachers to be more connected with students and	13	-1.633	-0.141	-1.493
34	Not all students can provide a BYOD device.	34	0.701	2.203	-1.502
5	With BYOD, students can use devices with which they are fami	5	-0.000	1.597	-1.597

19	Student familiarity with her/his own device is important.	19	-0.932	0.938	-1.869
33	BYOD gives the students unlimited access to information and	33	-1.512	1.702	-3.214

Exact Factor Scores (á la SPSS) in Z-score and T-Score units

			Factors					
No.	Statement	No.	1		2		3	
1	I am not for BYOD.	1	-1.60	34	0.72	57	-1.07	39
2	Excess bandwidth is due to all the non-academic applic	2	-1.00	40	1.07	61	-0.08	49
3	BYOD allows students to have opportunites to use devic	3	-1.05	39	-1.59	34	-0.43	46
4	BYOD devices will not support the higher end applicati	4	-1.62	34	-0.79	42	0.44	54
5	With BYOD, students can use devices with which they ar	5	0.64	56	-0.30	47	1.27	63
6	Environments where every student has a device allows e	6	1.16	62	-1.14	39	-0.25	48
7	Teachers will have to interact with different devices.	7	-0.37	46	-0.06	49	0.80	58
8	BYOD creates problems for teachers trying to get their	8	-0.15	49	1.55	66	1.63	66
9	It's much better for the school to provide consistent,	9	1.17	62	1.02	60	0.30	53
10	BYOD will increase cheating.	10	-1.67	33	0.04	50	-0.47	45
11	Students will often forget to charge their devices.	11	-0.87	41	1.97	70	-0.64	44
12	I don't beleive there is a benefit to BYOD.	12	-2.11	29	0.20	52	-0.39	46
13	BYOD allows teachers to be more connected with student	13	-0.76	42	-1.16	38	0.22	52
14	With BYOD, students can customize and use a device the	14	0.32	53	-0.25	47	-1.12	39
15	A student's BYOD device is potentially a better device	15	0.08	51	-0.72	43	0.92	59
16	BYOD allows instruction to become more student-centere	16	0.35	53	-1.63	34	-0.97	40
17	With BYOD, students can use devices they have setup to	17	0.02	50	-1.12	39	0.28	53
18	BYOD could get technology into students' hands if you	18	0.69	57	0.54	55	-2.01	30
19	Student familiarity with her/his own device is importa	19	0.49	55	-0.45	45	1.03	60
20	Students have the opportunity to see how a variety of	20	-0.93	41	-0.99	40	-0.10	49
21	BYOD provides an opportunity for hacking.	21	-0.48	45	1.12	61	-0.35	46
22	Environments where every student has a device allows f	22	1.61	66	-0.14	49	-0.62	44
23	Environments where every student has a device allows f	23	1.55	65	-0.19	48	-0.53	45
24	BYOD results in so many random issues that a classroom	24	-0.27	47	1.10	61	1.08	61
25	BYOD puts your network in danger from all the malware	25	-0.59	44	1.11	61	-0.86	41
26	The increase in access to technology is key for studen	26	1.09	61	-0.14	49	-1.28	37
27	BYOD provides possible cost savings.	27	0.47	55	0.59	56	-1.68	33
28	BYOD allows students to bring their technology to thei	28	-0.27	47	-1.59	34	0.11	51
29	The mix of BYOD devices in the classroom may conflict	29	-0.24	48	0.73	57	1.79	68
30	BYOD increases the percieved social pressure of the "h	30	0.98	60	1.07	61	0.69	57
31	Environments where every student has a device allow fo	31	1.30	63	0.05	50	-0.41	46
32	BYOD allows students the opportunity to leverage down	32	0.70	57	-0.32	47	-0.69	43

33	BYOD gives the students unlimited access to informatio	33	0.06	51	-1.49	35	1.99	70
34	Not all students can provide a BYOD device.	34	1.32	63	1.20	62	1.38	64

Factor Q-Sort Values for Each Statement

			Factor Arrays		
No.	Statement	No.	1	2	3
1	I am not for BYOD.	1	-4	2	-3
2	Excess bandwidth is due to all the non-academic applications	2	-2	3	-1
3	BYOD allows students to have opportunites to use devices and	3	-2	-3	-3
4	BYOD devices will not support the higher end applications we	4	-3	-2	-2
5	With BYOD, students can use devices with which they are fami	5	1	0	3
6	Environments where every student has a device allows expande	6	4	-2	0
7	Teachers will have to interact with different devices.	7	-1	0	1
8	BYOD creates problems for teachers trying to get their instr	8	-1	3	2
9	It's much better for the school to provide consistent, relia	9	2	1	2
10	BYOD will increase cheating.	10	-3	-1	-4
11	Students will often forget to charge their devices.	11	-3	4	-1
12	I don't beleive there is a benefit to BYOD.	12	-4	1	-4
13	BYOD allows teachers to be more connected with students and	13	-1	-4	0
14	With BYOD, students can customize and use a device they have	14	1	0	-1
15	A student's BYOD device is potentially a better device than	15	0	0	2
16	BYOD allows instruction to become more student-centered.	16	1	-3	-1
17	With BYOD, students can use devices they have setup to their	17	0	-2	0
18	BYOD could get technology into students' hands if you curren	18	1	3	-2
19	Student familiarity with her/his own device is important.	19	0	-2	2
20	Students have the opportunity to see how a variety of device	20	-2	-1	-1
21	BYOD provides an opportunity for hacking.	21	-1	2	0
22	Environments where every student has a device allows for imp	22	4	-1	1
23	Environments where every student has a device allows for enh	23	3	-1	1
24	BYOD results in so many random issues that a classroom canno	24	0	0	1
25	BYOD puts your network in danger from all the malware that s	25	-1	3	-2
26	The increase in access to technology is key for students.	26	3	-1	-2
27	BYOD provides possible cost savings.	27	2	1	-3
28	BYOD allows students to bring their technology to their lear	28	0	-3	0
29	The mix of BYOD devices in the classroom may conflict with t	29	-2	1	3
30	BYOD increases the percieved social pressure of the "haves v	30	2	2	3
31	Environments where every student has a device allow for incr	31	3	0	1
32	BYOD allows students the opportunity to leverage down time b	32	2	1	0

33	BYOD gives the students unlimited access to information and	33	0	-4	4
34	Not all students can provide a BYOD device.	34	1	1	4

Variance = 4.706 St. Dev. = 2.169

Factor Q-Sort Values for Statements sorted by Consensus vs. Disagreement (Variance across Factor Z-scores)

			Factor Arrays		
No.	Statement	No.	1	2	3
4	BYOD devices will not support the higher end applications we	4	-3	-2	-2
3	BYOD allows students to have opportunites to use devices and	3	-2	-3	-3
9	It's much better for the school to provide consistent, relia	9	2	1	2
20	Students have the opportunity to see how a variety of device	20	-2	-1	-1
30	BYOD increases the percieved social pressure of the "haves v	30	2	2	3
24	BYOD results in so many random issues that a classroom canno	24	0	0	1
32	BYOD allows students the opportunity to leverage down time b	32	2	1	0
14	With BYOD, students can customize and use a device they have	14	1	0	-1
15	A student's BYOD device is potentially a better device than	15	0	0	2
10	BYOD will increase cheating.	10	-3	-1	-4
17	With BYOD, students can use devices they have setup to their	17	0	-2	0
28	BYOD allows students to bring their technology to their lear	28	0	-3	0
7	Teachers will have to interact with different devices.	7	-1	0	1
13	BYOD allows teachers to be more connected with students and	13	-1	-4	0
31	Environments where every student has a device allow for incr	31	3	0	1
5	With BYOD, students can use devices with which they are fami	5	1	0	3
16	BYOD allows instruction to become more student-centered.	16	1	-3	-1
34	Not all students can provide a BYOD device.	34	1	1	4
19	Student familiarity with her/his own device is important.	19	0	-2	2
21	BYOD provides an opportunity for hacking.	21	-1	2	0
8	BYOD creates problems for teachers trying to get their instr	8	-1	3	2
27	BYOD provides possible cost savings.	27	2	1	-3
18	BYOD could get technology into students' hands if you curren	18	1	3	-2
29	The mix of BYOD devices in the classroom may conflict with t	29	-2	1	3
22	Environments where every student has a device allows for imp	22	4	-1	1
26	The increase in access to technology is key for students.	26	3	-1	-2
12	I don't beleive there is a benefit to BYOD.	12	-4	1	-4
23	Environments where every student has a device allows for enh	23	3	-1	1
1	I am not for BYOD.	1	-4	2	-3
25	BYOD puts your network in danger from all the malware that s	25	-1	3	-2
2	Excess bandwidth is due to all the non-academic applications	2	-2	3	-1
6	Environments where every student has a device allows expande	6	4	-2	0
11	Students will often forget to charge their devices.	11	-3	4	-1

33	BYOD gives the students unlimited access to information and	33	0	-4	4

Factor Characteristics

	Factors 1	2	3
No. of Defining Variables	7	2	3
Average Rel. Coef.	0.800	0.800	0.800
Composite Reliability	0.966	0.889	0.923
S.E. of Factor Z-scores	0.186	0.333	0.277

Standard Errors for Differences in Factor Z-scores

(Diagonal Entries Are S.E. Within Factors)

Factors	1	2	3
1	0.263	0.382	0.334
2	0.382	0.471	0.434
3	0.334	0.434	0.392

Distinguishing Statements for Factor 1

(P < .05 ; Asterisk (*) Indicates Significance at P < .01)

Both the Factor Q-Sort Value (Q-SV) and the Z-score (Z-SCR) are Shown.

			Factors 1		2		3	
No.	Statement	No.	Q-SV	Z-SCR	Q-SV	Z-SCR	Q-SV	Z-SCR
6	Environments where every student has a device allows expande	6	4	1.81*	-2	-0.93	0	-0.22
22	Environments where every student has a device allows for imp	22	4	1.73*	-1	-0.46	1	0.23
23	Environments where every student has a device allows for enh	23	3	1.69*	-1	-0.81	1	0.27
26	The increase in access to technology is key for students.	26	3	1.33*	-1	-0.57	-2	-0.82
31	Environments where every student has a device allow for incr	31	3	1.19	0	-0.34	1	0.39
16	BYOD allows instruction to become more student-centered.	16	1	0.43*	-3	-1.27	-1	-0.55
19	Student familiarity with her/his own device is important.	19	0	0.27	-2	-0.93	2	0.94
33	BYOD gives the students unlimited access to information and	33	0	-0.05*	-4	-1.51	4	1.70
8	BYOD creates problems for teachers trying to get their instr	8	-1	-0.56*	3	1.28	2	1.03
7	Teachers will have to interact with different devices.	7	-1	-0.66*	0	0.35	1	0.77
29	The mix of BYOD devices in the classroom may conflict with t	29	-2	-0.72*	1	0.58	3	1.45

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Distinguishing Statements for Factor 2

(P < .05 ; Asterisk (*) Indicates Significance at P < .01)

Both the Factor Q-Sort Value (Q-SV) and the Z-score (Z-SCR) are Shown.

			Factors					
			1		2		3	
No.	Statement	No.	Q-SV	Z-SCR	Q-SV	Z-SCR	Q-SV	Z-SCR
11	Students will often forget to charge their devices.	11	-3	-1.13	4	1.63*	-1	-0.80
2	Excess bandwidth is due to all the non-academic applications	2	-2	-1.02	3	1.51*	-1	-0.71
25	BYOD puts your network in danger from all the malware that s	25	-1	-0.51	3	1.51*	-2	-1.00
21	BYOD provides an opportunity for hacking.	21	-1	-0.71	2	1.16*	0	-0.24
1	I am not for BYOD.	1	-4	-1.39	2	0.92*	-3	-1.32
29	The mix of BYOD devices in the classroom may conflict with t	29	-2	-0.72	1	0.58	3	1.45
12	I don't beleive there is a benefit to BYOD.	12	-4	-1.77	1	0.57*	-4	-1.36
10	BYOD will increase cheating.	10	-3	-1.36	-1	-0.36*	-4	-1.62
23	Environments where every student has a device allows for enh	23	3	1.69	-1	-0.81	1	0.27
19	Student familiarity with her/his own device is important.	19	0	0.27	-2	-0.93*	2	0.94
17	With BYOD, students can use devices they have setup to their	17	0	0.28	-2	-1.05	0	-0.10
28	BYOD allows students to bring their technology to their lear	28	0	-0.05	-3	-1.39	0	-0.43
33	BYOD gives the students unlimited access to information and	33	0	-0.05	-4	-1.51*	4	1.70
13	BYOD allows teachers to be more connected with students and	13	-1	-0.72	-4	-1.63	0	-0.14

PQMethod2.35 BYOD_PZ PAGE 18

Path and Project Name: C:\Users\khlarwin\Desktop\PQMethod/BYOD_PZ Mar 14 19

Distinguishing Statements for Factor 3

(P < .05 ; Asterisk (*) Indicates Significance at P < .01)

Both the Factor Q-Sort Value (Q-SV) and the Z-score (Z-SCR) are Shown.

			Factors					
			1		2		3	
No.	Statement	No.	Q-SV	Z-SCR	Q-SV	Z-SCR	Q-SV	Z-SCR
34	Not all students can provide a BYOD device.	34	1	0.67	1	0.70	4	2.20*
33	BYOD gives the students unlimited access to information and	33	0	-0.05	-4	-1.51	4	1.70*
5	With BYOD, students can use devices with which they are fami	5	1	0.38	0	-0.00	3	1.60*
29	The mix of BYOD devices in the classroom may conflict with t	29	-2	-0.72	1	0.58	3	1.45
19	Student familiarity with her/his own device is important.	19	0	0.27	-2	-0.93	2	0.94
15	A student's BYOD device is potentially a better device than	15	0	-0.20	0	-0.23	2	0.78
23	Environments where every student has a device allows for enh	23	3	1.69	-1	-0.81	1	0.27
32	BYOD allows students the opportunity to leverage down time b	32	2	0.79	1	0.70	0	-0.16
18	BYOD could get technology into students' hands if you curren	18	1	0.67	3	1.17	-2	-0.86*

27 BYOD provides possible cost savings. 27 2 0.83 1 0.69 -3 -1.02*

Consensus Statements -- Those That Do Not Distinguish Between ANY Pair of Factors.

All Listed Statements are Non-Significant at P>.01, and Those Flagged With an * are also Non-Significant at P>.05.

			Factors					
			1		2		3	
No.	Statement	No.	Q-SV	Z-SCR	Q-SV	Z-SCR	Q-SV	Z-SCR
3*	BYOD allows students to have opportunites to use devices and	3	-2	-0.99	-3	-1.39	-3	-1.04
4*	BYOD devices will not support the higher end applications we	4	-3	-1.34	-2	-1.17	-2	-0.96
9*	It's much better for the school to provide consistent, relia	9	2	1.18	1	0.69	2	1.13
20*	Students have the opportunity to see how a variety of device	20	-2	-1.03	-1	-0.81	-1	-0.48
30*	BYOD increases the percieved social pressure of the "haves v	30	2	0.73	2	0.93	3	1.30

QANALYZE was complete at 12:44:52

APPENDIX C

Q-Sort Arrays

Disagree Most ... Agree Most

-4	-3	-2	-1	0	1	2	3	4
1	10	2	29	14	18	33	3	16
12	27	24	11	7	15	23	31	26
	9	25	8	17	19	22	28	
		21	4	5	6	20		
			30	32	13			
				34				

IDCODE: 01FS39

Disagree Most ... Agree Most

-4	-3	-2	-1	0	1	2	3	4
11	12	2	33	26	28	32	23	22
4	29	27	10	21	31	19	14	16
	8	3	13	7	30	9	6	
		20	25	17	15	18		
			24	1	5			
				34				

IDCODE: 02MS11

Disagree Most								Agree Most
-4	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**
11	7	19	3	5	14	26	30	9
10	8	21	4	24	18	31	34	27
	2	29	15	13	16	22	6	
		20	28	1	17	23		
			25	12	33			
				32				

IDCODE: 03MU49

Disagree Most								Agree Most
-4	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**
33	12	4	7	10	26	23	9	34
1	16	24	8	19	15	27	25	30
	29	11	32	28	3	18	21	
		2	6	31	17	14		
			22	5	13			
				20				

IDCODE: 04FS15

Disagree Most | Agree Most

-4	-3	-2	-1	0	1	2	3	4
4	6	10	2	14	21	23	22	18
28	17	12	20	19	32	34	27	11
	3	33	25	30	26	9	31	
		15	8	7	16	1		
			13	5	29			
				24				

IDCODE: 05MS10

Disagree Most | Agree Most

-4	-3	-2	-1	0	1	2	3	4
4	1	24	3	19	18	32	23	26
10	15	21	8	11	28	22	9	6
	12	29	16	7	17	5	31	
		25	30	20	14	33		
			13	2	27			
				34				

IDCODE: 06MS49

Disagree Most								Agree Most
-4	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**
14	4	24	13	21	8	7	5	9
1	12	27	23	18	31	29	19	34
	10	25	26	22	20	15	32	
		16	11	30	2	17		
			3	28	33			
				6				

IDCODE: 07MS12

Disagree Most								Agree Most
-4	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**
13	10	19	12	9	31	32	8	18
4	17	3	16	27	16	21	2	11
	33	6	24	1	14	34	25	
		28	20	22	29	30		
			23	5	7			
				15				

IDCODE: 08MS07

Disagree Most								Agree Most
-4	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**
12	1	15	25	18	34	27	23	26
3	13	2	21	11	19	30	31	22
	20	5	14	7	8	24	6	
		28	10	33	29	4		
			17	32	9			
				16				

IDCODE: 09MR48

Disagree Most								Agree Most
-4	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**
27	32	25	18	7	23	22	13	33
10	21	3	14	19	15	9	24	29
	2	17	20	28	8	5	34	
		4	26	12	31	30		
			6	1	11			
				16				

IDCODE: 10FR39

Disagree Most								Agree Most
-4	-3	-2	-1	0	1	2	3	4
1	11	10	25	33	31	5	27	15
12	24	21	7	28	19	23	16	32
	2	4	13	34	29	6	22	
		9	8	30	14	18		
			20	3	17			
				26				

IDCODE: 11MS21

Disagree Most								Agree Most
-4	-3	-2	-1	0	1	2	3	4
12	18	28	10	9	15	21	8	34
11	13	26	2	31	27	14	33	30
	1	20	16	32	23	19	5	
		3	25	17	29	7		
			22	4	24			
				6				

IDCODE: 12FT34

Disagree Most								Agree Most
-4	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**
7	33	13	32	29	19	30	23	8
20	3	16	18	5	31	34	22	24
	4	1	14	15	2	26	6	
		12	21	17	25	9		
			27	28	11			
				10				

IDCODE: 13MT47

APPENDIX D

Frequency Statistics for Technological Determinism Survey Questions

```
GET
  FILE='C:\Users\Owner\Desktop\Dissertation Working Copies\PreK-12
Technology Leader Perceptions of Bring Your Own Device BYOD pr.sav'.
DATASET NAME DataSet1 WINDOW=FRONT.
FREQUENCIES VARIABLES=TD_ALTER_ESSENCE TD_SOCIETY_DEPENDENT
TD_MACHINE_ALTER_EXISTENCE
    TD_PRODUCT_OF_PEOPLE TD_SOCIETY_CONTROLS TD_EQUALS_PROGRESS
TD_LITTLE_IMPACT TD_WEAK_INFLUENCE
  /STATISTICS=STDDEV MINIMUM MAXIMUM MEAN MEDIAN MODE
  /HISTOGRAM NORMAL
  /ORDER=ANALYSIS.
```

Frequencies

Notes

Output Created		29-MAR-2019 10:02:52
Comments		
Input	Data	C:\Users\Owner\Desktop\Dissertation Working Copies\PreK-12 Technology Leader Perceptions of Bring Your Own Device BYOD pr.sav
	Active Dataset	DataSet1
	File Label	File created by user 'asyncjobs_user' at Wed Jan 16 23:37:38 201
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	24
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data.

Syntax		FREQUENCIES VARIABLES=TD_ALTER_ESSENCE TD_SOCIETY_DEPENDENT TD_MACHINE_ALTER_EXISTENCE TD_PRODUCT_OF_PEOPLE TD_SOCIETY_CONTROLS TD_EQUALS_PROGRESS TD_LITTLE_IMPACT TD_WEAK_INFLUENCE /STATISTICS=STDDEV MINIMUM MAXIMUM MEAN MEDIAN MODE /HISTOGRAM NORMAL /ORDER=ANALYSIS.
Resources	Processor Time	00:00:04.36
	Elapsed Time	00:00:02.02

```
[DataSet1] C:\Users\Owner\Desktop\Dissertation Working Copies\PreK-12
Technology Leader Perceptions of Bring Your Own Device BYOD pr.sav
```

Statistics

		Technology has the power to alter the very essence of daily life.	Society is dependent on technology. As a result, technology is key in maintaining social order.	Machines make history by changing the material conditions of human existence. Through technology human existence is altered economically, spiritually, and morally.	Technology is the product of human actions - its power to change society is a product of the time and place in which it is introduced.	Society controls and shapes the impact of technology on daily life.	Technology equals progress.	Technology has little material impact on daily life.	Technology exerts a weak influence on social order when compared to other factors.
N	Valid	18	18	18	18	18	18	18	18
	Missing	6	6	6	6	6	6	6	6
Mean		1.3889	2.1111	2.2778	1.8333	2.1667	2.7778	4.1667	3.5000
Median		1.0000	2.0000	2.0000	2.0000	2.0000	3.0000	4.0000	3.5000
Mode		1.00	2.00	2.00	2.00	2.00	3.00	4.00	3.00[a]
Std. Deviation		.60768	.67640	.75190	.51450	.92355	1.00326	.61835	.70711
Minimum		1.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00
Maximum		3.00	4.00	4.00	3.00	4.00	5.00	5.00	5.00

a. Multiple modes exist. The smallest value is shown

Frequency Table

Technology has the power to alter the very essence of daily life.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	12	50.0	66.7	66.7
	Agree	5	20.8	27.8	94.4
	Neither agree nor disagree	1	4.2	5.6	100.0
	Total	18	75.0	100.0	
Missing	System	6	25.0		
Total		24	100.0		

Society is dependent on technology. As a result, technology is key in maintaining social order.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	2	8.3	11.1	11.1
	Agree	13	54.2	72.2	83.3
	Neither agree nor disagree	2	8.3	11.1	94.4
	Disagree	1	4.2	5.6	100.0
	Total	18	75.0	100.0	
Missing	System	6	25.0		
Total		24	100.0		

Machines make history by changing the material conditions of human existence. Through technology human existence is altered economically, spiritually, and morally.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	2	8.3	11.1	11.1
	Agree	10	41.7	55.6	66.7
	Neither agree nor disagree	5	20.8	27.8	94.4
	Disagree	1	4.2	5.6	100.0
	Total	18	75.0	100.0	
Missing	System	6	25.0		
Total		24	100.0		

Technology is the product of human actions - its power to change society is a product of the time and place in which it is introduced.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	4	16.7	22.2	22.2
	Agree	13	54.2	72.2	94.4
	Neither agree nor disagree	1	4.2	5.6	100.0
	Total	18	75.0	100.0	
Missing	System	6	25.0		
Total		24	100.0		

Society controls and shapes the impact of technology on daily life.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	4	16.7	22.2	22.2
	Agree	9	37.5	50.0	72.2
	Neither agree nor disagree	3	12.5	16.7	88.9
	Disagree	2	8.3	11.1	100.0
	Total	18	75.0	100.0	
Missing	System	6	25.0		
Total		24	100.0		

Technology equals progress.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	2	8.3	11.1	11.1
	Agree	4	16.7	22.2	33.3
	Neither agree nor disagree	9	37.5	50.0	83.3
	Disagree	2	8.3	11.1	94.4
	Strongly disagree	1	4.2	5.6	100.0
	Total	18	75.0	100.0	
Missing	System	6	25.0		
Total		24	100.0		

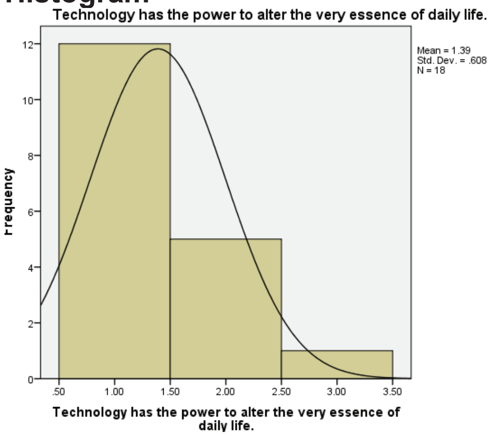
Technology has little material impact on daily life.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neither agree nor disagree	2	8.3	11.1	11.1
	Disagree	11	45.8	61.1	72.2
	Strongly disagree	5	20.8	27.8	100.0
	Total	18	75.0	100.0	
Missing	System	6	25.0		
Total		24	100.0		

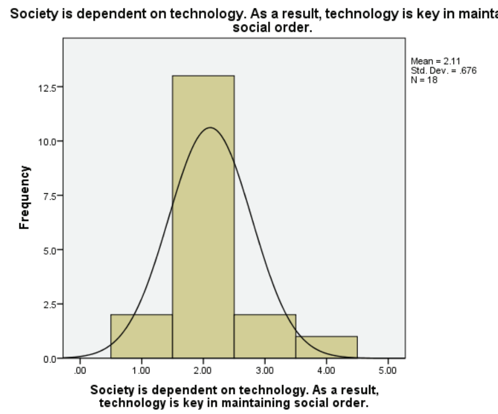
Technology exerts a weak influence on social order when compared to other factors.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	1	4.2	5.6	5.6
	Neither agree nor disagree	8	33.3	44.4	50.0
	Disagree	8	33.3	44.4	94.4
	Strongly disagree	1	4.2	5.6	100.0
	Total	18	75.0	100.0	
Missing	System	6	25.0		
Total		24	100.0		

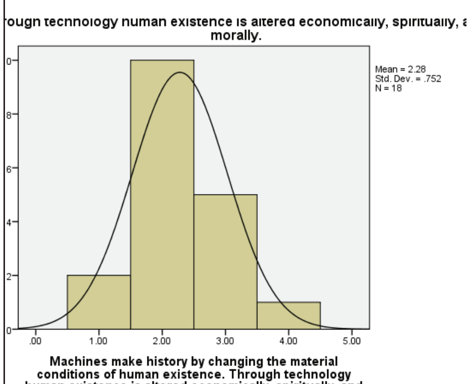
Histogram



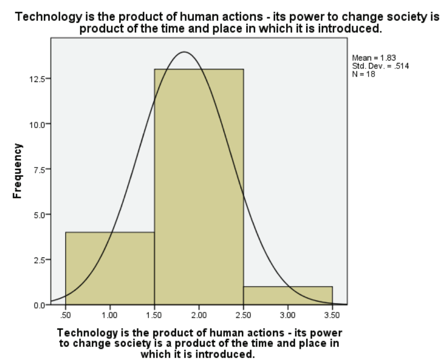
Technology has the power to alter the very essence of daily life.
Mean = 1.39
Std. Dev. = .608
N = 18
Frequency
Technology has the power to alter the very essence of daily life.



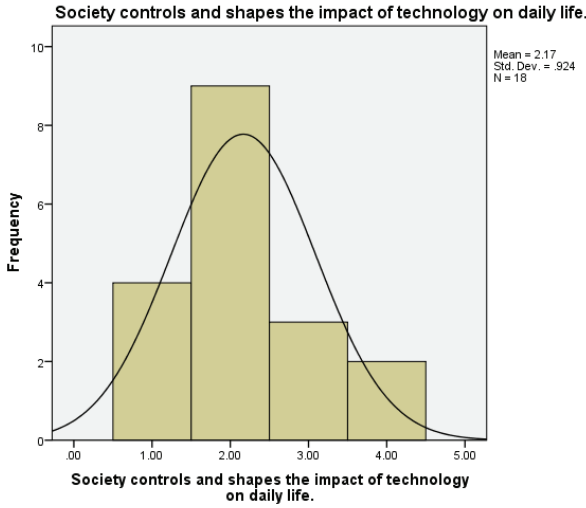
Society is dependent on technology. As a result, technology is key in mainta
social order.
Mean = 2.11
Std. Dev. = .676
N = 18
Frequency
Society is dependent on technology. As a result, technology is key in maintaining social order.

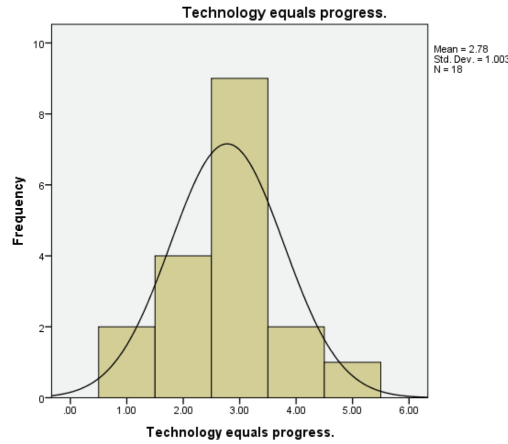


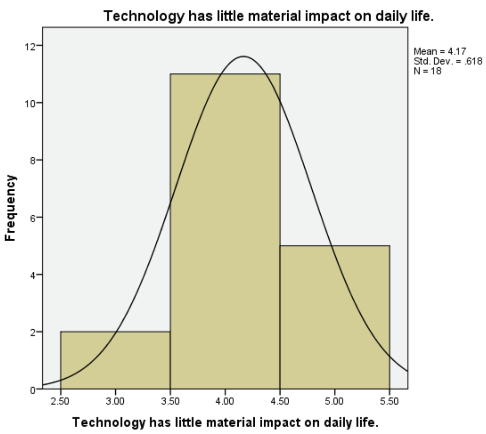
rough technology human existence is altered economically, spiritually, a
morally.
Mean = 2.28
Std. Dev. = .752
N = 18
Machines make history by changing the material conditions of human existence. Through technology

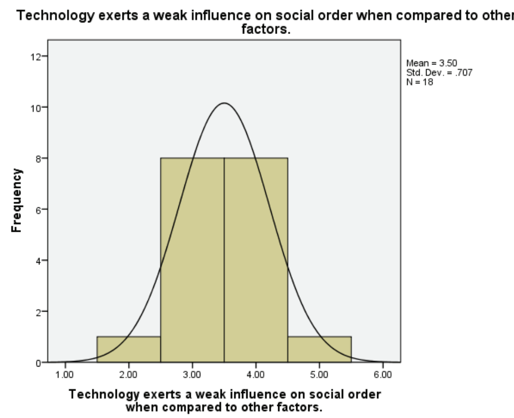


Technology is the product of human actions - its power to change society is a product of the time and place in which it is introduced.
Mean = 1.83
Std. Dev. = .514
N = 18
Frequency
Technology is the product of human actions - its power to change society is a product of the time and place in which it is introduced.


Society controls and shapes the impact of technology on daily life.
Mean = 2.17
Std. Dev. = .924
N = 18
Frequency
Society controls and shapes the impact of technology on daily life.


Technology equals progress.
Mean = 2.78
Std. Dev. = 1.003
N = 18
Frequency
Technology equals progress.


Technology has little material impact on daily life.
Mean = 4.17
Std. Dev. = .618
N = 18
Frequency
Technology has little material impact on daily life.


Technology exerts a weak influence on social order when compared to other factors.
Mean = 3.50
Std. Dev. = .707
N = 18
Frequency
Technology exerts a weak influence on social order when compared to other factors.

APPENDIX E

IRB Approval

YOUNGSTOWN STATE UNIVERSITY

One University Plaza, Youngstown, Ohio 44555
Office of Research
330.941.2377

October 16, 2018

Dr. Karen Larwin, Principal Investigator
Mr. Peter Zagray, Co-investigator
Department of Counseling, School Psychology & Educational Leadership
UNIVERSITY

RE: HSRC PROTOCOL NUMBER: 031-2019
TITLE: Perceived Impact of One-to-One Computing in K-12

Dear Dr. Larwin and Mr. Zagray:

The Institutional Review Board has reviewed the abovementioned protocol and determined that it is exempt from full committee review based on a DHHS Category 3 exemption.

Any changes in your research activity should be promptly reported to the Institutional Review Board and may not be initiated without IRB approval except where necessary to eliminate hazard to human subjects. Any unanticipated problems involving risks to subjects should also be promptly reported to the IRB.

The IRB would like to extend its best wishes to you in the conduct of this study.

Sincerely,

[redacted]

Dr. Greg Dillon
Interim Associate Vice President for Research
Authorized Institutional Official

GD:cc

c: Dr. Jake Protivnak, Chair
Department of Counseling, School Psychology & Educational Leadership