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Bring Your Own Device (BYOD) programs in the classroom: teacher use, equity, and learning tools

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BRING YOUR OWN DEVICE (BYOD) PROGRAMS IN THE CLASSROOM:

TEACHER USE, EQUITY, AND LEARNING TOOLS

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ABSTRACT

This study explores teacher perceptions of Bring Your Own Device (BYOD) programs in the classroom, with a focus on teacher use, student equity of access, and student ability to use their devices as learning tools. While one-to-one laptop programs (students assigned identical school-owned laptop or tablet) has an extensive body of literature behind it, BYOD has relatively little peer-reviewed research.

A framework was developed to guide this research that related teacher technology use, equity of student access, and student ability to learn to use the devices they brought. Two instruments were created to collect data: (a) an anonymous online survey to collect information from 108 teachers already incorporating BYOD into their classes, (b) a semi-structured interview with eleven teachers who volunteered after completing the first instrument.

Findings suggested that teachers with constructivist compatible beliefs were likely to have more positive perceptions of BYOD, as were those who worked in schools with a more positive atmosphere. Very few teachers (12%) thought that BYOD programs were inherently inequitable, although 25% thought the programs in their own school was inequitable. Teachers were concerned that all students have access to an effective device when the student did not bring one and they primarily looked to school-owned technology to be available. Teachers also reported that students could learn to use their individual devices by working with other students and through working on assignments, while teachers had specific techniques they used to support this learning. Teachers overall did not view themselves as being responsible for providing technology support to students, and instead expected students to resolve their own technology problems. Many teachers (42%) liked that students had different types of devices.

A key advantage of BYOD is the knowledge the students bring when they bring their own device. These results provide tentative support for Bring Your Own Device programs as a viable, cost- effective way for students to use their own technology for learning.

Chapter 1. The Problem

In spite of efforts by schools to purchase more technology for use in learning, students frequently use technology in school much less and have less access than they do out of school (Lim, Yong, Tondeur, Sing, & Tsai, 2013). Yet, in a nationwide survey, almost 90% of high school students owned a smartphone, two-thirds owned a laptop, and half owned a tablet. For middle school students in grades 6-8, almost three-quarters owned a smartphone, two-thirds owned a laptop, and 61% owned a tablet (Project Tomorrow, 2014). Over half of the surveyed students grade 6 -12 students wanted their schools to incorporate their personal mobile devices in instruction (Project Tomorrow & Blackboard K-12, 2014). Those students wanted their schools to participate in a *Bring Your Own Device* (BYOD) program so that they could bring their own devices to use in instruction as learning tools. While schools have started to implement BYOD programs, there is only limited research to help schools decide how to develop and structure such BYOD programs, how to address equity among students when some may not have a device to bring, or how to support their teachers. The intent of this research project is to provide some of that guidance to schools.

Genesis: An Early Bring Your Own Device (BYOD) Project

A short overview of an early BYOD project, can illustrate some of the issues and tensions that might arise when students use their own devices. That early BYOD program was begun during my tenure as a technology director for an independent international school. There, middle school administrators, teacher volunteers, and technology staff collaborated to form a pilot team to implement a one student to one laptop (one-to-one) program where middle school students brought their personal laptops to school. This was a BYOD program as students' personal mobile devices were being used in instruction, although the term was not known then. Unlike a one-to-one laptop program where the school provides the laptops (Silvernail & Lane, 2004), or where the parents purchase a laptop chosen by the school (Brass, 2008), the middle school students could bring whichever type of laptop their parents allowed as

a long as it met school-specified performance and capability minimums. The goal of the teachers who volunteered for the pilot program was to take advantage of the benefits a one-to-one program provided while avoiding problems inherent in school-owned computers. This goal arose from the belief that having students bring their own laptops was a logical implementation of a one-to-one program, even though no research existed on the topic. Other educators, both in the school and out, disagreed with the idea that having students bring their own laptops was a logical extension of a one-to-one program. The excitement and successes, along with the inevitable difficulties, disagreements, and occasional discouragement, of the project revealed both the potential and the challenges of using student-owned computers in the classroom. Ultimately, the school administration demonstrated their confidence in the program by requiring all middle and high school students to bring their personal laptops.

At the time of the pilot program, a nascent movement arose in independent and some public schools to allow students to bring their own electronic devices, not just computers but Internet-connected phones and other Internet-enabled computers, and use them in the classroom. Yet, almost no research existed on the efficacy of using personal devices in instructional contexts.

Challenges in an Early BYOD Project

With no published research on *Bring Your Own Laptop* (BYOL), teachers in the pilot program knew they were innovating. Even so, the pilot team did not approach BYOL atheoretically. The pilot team used various research articles and reports (Bebell, 2005; Bonifaz & Zucker, 2004; Donovan, Hartley, & Strudler, 2007; Lei & Zhao, 2008; Penuel, 2006; Warschauer, 2008) from other laptop program implementations to guide them. Yet, when the pilot team discussed BYOL with other educators who were familiar with one-to-one programs, even if the others had not participated in such a program, the description of the BYOL program elicited dichotomous responses. Some educators quickly understood and concurred with the reasoning the pilot team were using to guide their implementation of the BYOL program. Other educators, even some who were strong proponents of one-to-one

programs, struggled with the concept of BYOL. These latter educators still had strong reservations, even when the pilot team discussed the research literature used to help design the program and explained why they viewed BYOL as a logical extension of a one-to-one program. While not obvious at the time to the pilot team, the resistance they encountered an indicator that they were early adopters of an innovation (Rogers, 2003).

Part of the divide among the staff and other educators inside and outside the school became evident as pedagogical and implementation issues arose during the pilot and roll-out. Proponents of school-provided laptops for one-to-one programs asked, for example, how teachers would be able to teach when students had different computers and different software, and how teachers could show students how to use a program, such as a movie editing program, when the programs on student computers would not only be different, but could look different and operate differently.

Those questions revealed three implicit assumptions on the part of the questioners. The first assumption was that teaching with technology in the classroom requires uniformity of the technology used by students. The second assumption was that teaching students how to use technology requires direct instruction to students about how to use their computers and software. The third assumption was that software was so different between computers that teachers had to show students how to use their specific software and computers. The pilot team, in trying to challenge those assumptions, could not find research that addressed these questions. Even the research and reports addressing traditional one-to-one programs, such as Dunleavy, Dexter, and Heinecke (2007), Russell, Bebell, and Higgins (2004), and Silvernail and Lane (2004), had the implicit assumption that the computers used by students were identical in the classroom. That is, the computers were the same model and operating system; uniformity was a hallmark of those programs. Without research that directly addressed the BYOL implementation, teachers used experience and passion to address those pedagogical and process questions in planning and practice; they were the innovators (Rogers, 2003). The questioners also had a

fourth assumption, never explicitly stated but evident to the pilot team through tone and choice of words, that the team had undertaken a pilot without considering issues that would arise when students were using different computers with different capabilities, and with operating systems in different languages.

The term for the pilot program would now be a BYOD (Bring Your Own Device), BYOT (Bring Your Own Technology), or BYOL (Bring Your Own Laptop) program, but at the time the pilot planning began in the second half of 2009, these terms were not in common use and the administrators, teachers, and the technology staff on the pilot team were unaware of them. The team modeled the program, where students brought their own chosen laptops, after one already implemented in an independent school in the United States and referred to as the *y'all come* model, as in, "y'all come with whatever you have" (Hudkins, 2005). As of this writing, the most common shorthand convention for referring to programs where students bring whatever technology they have, whether smart phones, tablets, or more powerful devices, is to use the term Bring Your Own Device (BYOD). For the purposes of this current research, a program where the school requires students to bring their laptops is a Bring Your Own Laptop (BYOL) program.

Statement of the Problem

Schools that implement a Bring Your Own Device (BYOD) program in their schools still do so with very little research evidence directly related to BYOD. Currently, they have to rely on research that describes a similar effort of matching each student with a school-provided laptop. While there are articles in education trade publications and blogs suggesting BYOD as a practice schools should adopt, there are also dissenters who raise concerns in blogs and online forums that implementing a BYOD program will reduce learning possibilities or increase inequity.

In my roles as a school technology director, state educational technology director, and state education project manager, I have had opportunities to discuss BYOD with local, state, and federal policy

makers. Some see BYOD as a way for schools to use more digital technologies by having student bring devices so that schools have can use their limited funding to support students who may not have a device. Others see BYOD as anathema to equity and effective digital learning. Those who are uneasy about BYOD seem to be concerned that most schools, when implementing BYOD programs, will end up with one of two results. The first result would be that schools fail to provide for those students who do not have a device, resulting in increased inequity in classrooms and schools. The second result would be that the devices that students bring would only be suitable for consuming content from the Internet, not for creation and collaboration. In this second scenario, schools might believe that their students were effective technology users and that the school was preparing students to use emerging technologies but, in reality the school would be far from realizing the potential technology in the classroom. The diverse views surrounding BYOD make it plain that BYOD is receiving serious consideration by schools, but school administrators and teachers have little research to guide them on BYOD. Additional research on BYOD programs has the potential to provide administrators and teachers a better framework to understand effective practices and effects on learning when students bring their own devices.

Purpose of the Study

The purpose of the study is to understand how teachers in K-12 schools implement a Bring Your Own Device (BYOD) program in their classroom and their perception of students learning with, or the successes and challenges of, their BYOD program. Implementation includes how teachers have students use their devices, the challenges teachers face, and how teachers address students' technology skills. Teachers' perceptions of the successes and challenges of their BYOD program includes their perception of students' equitable access to devices when some students may not be able to bring one, as well as teachers' overall perceptions of how BYOD is enabling learning in the classroom.

Conceptual Framework

The conceptual framework developed to guide this study is rudimentary and exploratory (Miles & Huberman, 1994) as no well-developed theories or research findings specific to BYOD exist. While research does exist on one-to-one implementations using laptops or tablet devices, BYOD includes all Internet-enabled devices, not just BYOL and tablets and, as noted previously, one-to-one research implicitly assumes that students use the same device. However, drawing on what is known about the implementation and effectiveness of other student technology programs, I have created a conceptual framework to explore in this research.

This conceptual framework study suggests that the effectiveness of BYOD programs is likely to be related to the interaction among three primary dimensions.

1. Teachers' use of digital technology for their professional work and for instruction.
2. Student access to digital technology.
3. Student ability to learn to use their devices for learning.

Research on teacher technology use in schools has shown that teachers' face extrinsic and intrinsic barriers when they try to use digital technology (Bingimlas, 2009; Ertmer, 1999); that teacher beliefs affect how teachers implement digital technology and use it for instruction (Riel & Becker, 2000; Tondeur, Hermans, van Braak, & Valcke, 2008); and that professional development has the potential to change teacher beliefs and practices with regard to digital technology use in the classroom (Harris & Hofer, 2011; Voogt et al., 2011). Asking students to provide their own access to technology by bringing a device, even if it is not required, may lead to inequity and access issues among students (Baule, 2012; Watters, 2012). How students learn to use their devices for learning in the classroom where every student may have a different device has not been studied, but students can learn to use digital technologies with limited or no instruction (Lei & Zhao, 2008; Mitra et al., 2005; Negroponte, 2009;

Papert, 1993). Figure 1 illustrates the relationships among the three dimensions of the framework that are explored in this research.

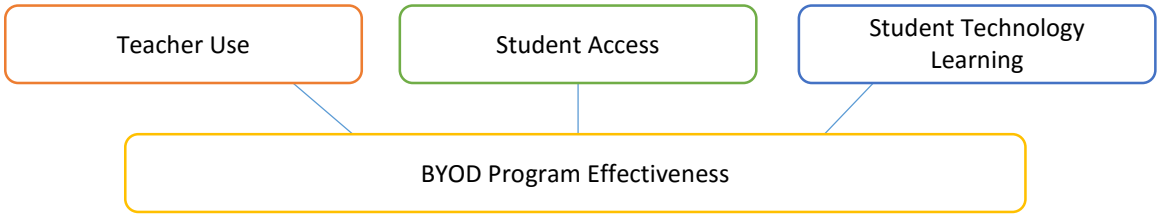

Figure 1. Relationships of conceptual framework dimensions in support of effective BYOD programs.

Significance of the Study

Many trade publications and online resources have published articles on BYOD, e.g., Raths (2012) and Devaney (2012), with the mainstream press following, e.g., St. George (2014). Such publications may discuss successes and challenges, but the results frequently come from anecdotes in individual schools rather than purposeful inquiry. Help guides are also available to schools who are considering a BYOD program, such as those available from education agencies (Alberta Education, 2012; New South Wales Department of Education, 2013), teacher magazines, or blogs that attempt to address BYOD and learning. Vendors also produce white papers and other literature in an attempt to convince school personnel to purchase their solution for network management for mobile devices, (Cisco, n.d.; Dixon & Tierney, n.d.). While education trade journals have contained articles favorable to BYOD, the U.S. Department of Education has issued a warning on BYOD without including research or citations (United States Department of Education Office of Educational Technology, 2016). Creating a formal research base for BYOD may guide effective implementation, but creating that base necessitates a shift in focus from technical tools to learning (Islam & Grönlund, 2016).

With the current paucity of peer-reviewed research, this study will increase understanding of how teachers incorporate student selected devices in their planning and instruction, the challenges they face, and how they perceive that students *learn with* their devices as well as *learn to use* all the

capabilities of their devices. Results from this study will be useful to schools and teachers as they plan a BYOD program or work to improve current BYOD programs.

Limitations of the Study

This study is limited as data collection depended on teachers volunteering to participate in the research, and all analysis was filtered through their perceptions. Teachers who were interested in having their students use technology in the classroom were possibly more likely to participate. With volunteers as participants, it was also possible that certain K-12 education sectors may be over-represented or under-represented. Generalizing the results may also be problematic for schools with special needs, such as those with a large number of migrant students or inner city schools.

Another limitation may be that teachers in schools with well-developed BYOD programs did not participate, either because they were already reporting on their instructional use of BYOD, or because they have been doing BYOD long enough that they did not believe their practice was worthy of contributing to a survey. Conversely, teachers who have a BYOD program that is not functioning well may also have chosen not to participated.

Research Questions

The conceptual framework guided the development of the research questions. This study seeks to answer the following research questions with regards to BYOD programs:

1. How is teacher incorporation of student devices in instruction related to their own beliefs and practices around the use of technology professionally and for instruction?
    - How are their practices affected by the school support for technology?
    - How are their practices influenced by the school implementation of a BYOD program?
2. To what extent do teachers perceive that BYOD programs provide equitable access for all students?

3. To what extent do teachers perceive that students are successful in using their own technology for learning in a BYOD classroom?

As this study was not longitudinal, the efficacy of professional development to change teacher beliefs was not included in the research questions, although it is important to consider in the framework. Figure 2 illustrates the mapping of the research questions to the conceptual framework dimensions.

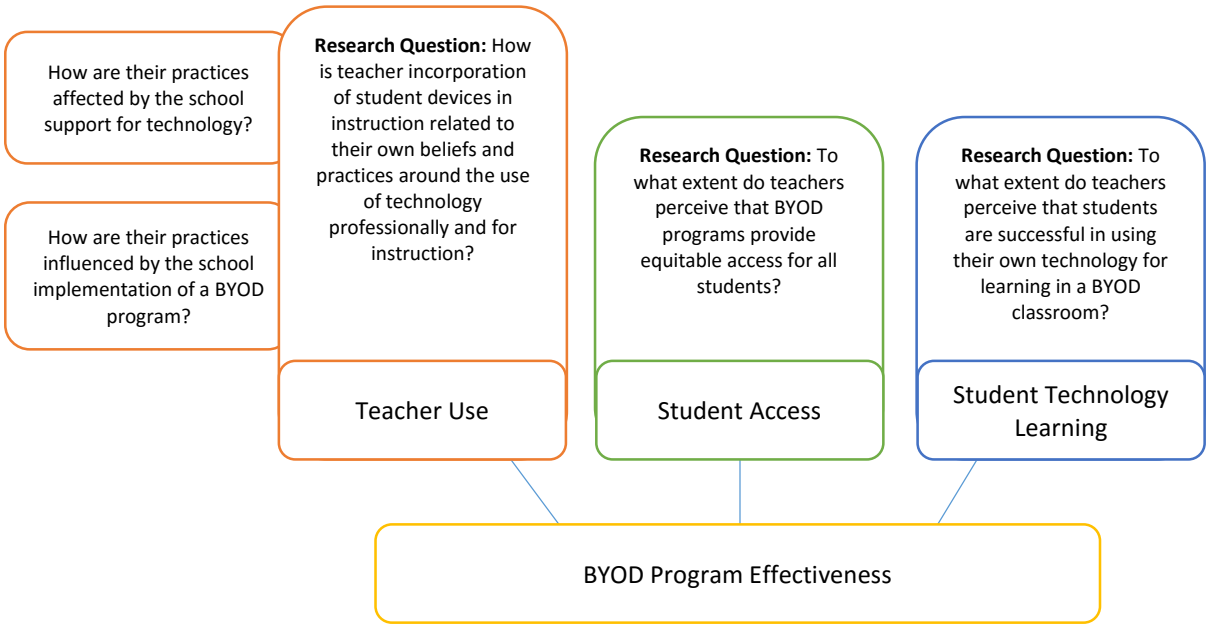

Figure 2. Relationship of research questions to conceptual framework dimensions.

Proposed Method

The proposed research method is a mixed method study using a triangulation design of a data transformation model, that is, quantitative and qualitative data was collected and analyzed, then qualitative data was transformed into quantitative data in order to compare and interrelate the now-quantitative data sets. The quantitative data was collected through a survey of teachers who have experience in BYOD programs. The qualitative data was primarily collected through interviews with teachers who complete the initial survey and volunteer for the interviews.

Conclusion

The purpose of the study was to understand how teachers in K-12 schools implement a Bring Your Own Device (BYOD) program in their classroom and their perception of students learning with, or the successes and challenges of, their BYOD program. The conceptual framework for this study is that the effectiveness of BYOD programs is related to the interaction among three dimensions: teachers' uses of digital technology for their professional work and for instruction; student access to digital technology; and student ability to use their devices for learning in school. The mixed methods research design was intended to address three main questions about how teachers incorporate students' devices in their classrooms, where the questions are tied to the conceptual framework dimensions of teacher use, student access, and student technology learning.

As schools adopt BYOD programs, more research is needed to help the teachers and schools implement effective programs, and the results of this study will be one piece of this research.

Chapter 2. Literature Review

Introduction

Students in elementary and secondary schools are acquiring their own Internet-connected devices in greater numbers each year (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013; Project Tomorrow, 2013b), yet most schools are unsure how to incorporate these student-owned devices into school. Over 60% of U.S. schools have policies restricting student-owned device use that teachers believe has an impact on their teaching (Purcell, Heaps, Buchanan, & Friedrich, 2013), while other schools embrace them. Research on student use of technology often assumes that students all have the same type of device and current research provides little guidance on conditions necessary for effective use of student-owned devices.

Yet some schools are trying to harness the power of student-owned devices in their schools through Bring Your Own Device (BYOD) programs, sometimes known as Bring Your Own Technology (BYOT) programs, where students can use their own devices as learning tools. These programs have the potential to improve student access to technology for learning in schools by allowing every student to have access to a powerful device in school. Unlike traditional laptop or one-to-one programs where schools, districts, or governments provide identical devices to all students in a grade or in a school, BYOD programs depend on students bringing their own Internet-capable devices.

While the effects of technology in the classroom on student learning have been widely researched for programs where the students have identical devices, almost no research exists for cases where students have devices with different capabilities. The primary approach to student technology use in schools with one-to-one programs has been to have essentially identical computers or tablets in a class, whether provided through the school or government or, frequently in the case of independent schools, by the parents. Yet the research does not cover some of the factors that may occur in a BYOD environment where the devices the students bring are not specified by the school and have different

capabilities and affordances. For example, teachers, unfamiliar with the operating details of the variety of devices their students bring, may feel unsure of how to help students learn to use those devices. They may also be unsure about how to structure assignments and manage a classroom when devices have different capabilities. Such differences in capability may include suitability for content creation, such as an appropriate screen size or input method for documents, the ability to do meaningful work in programming, video editing, or media, and the ability to collaborate. Furthermore, if students provide their own devices, schools and teachers may be unsure how to handle the situations where some of the students, for whatever reason, do not have access to such a device.

Allowing students to use their own technology in class and in school can bring benefits to students, teachers, and schools. Students can access information through the Internet or collaborate online without going to the school library or computer lab and they can do so when the need arises. Teachers can design all lessons with the assumption that access to online resources will be available during class rather than having to limit lessons when no technology is available. Schools can direct more resources to helping students who do not have access as students who bring their own device will not need as many technology resources.

How students learn in classrooms where students use their own devices potentially depends on whether students have a useful device available, how students learn to effectively use their devices, and how well teachers are able to take advantage of the presence of the devices to improve student learning.

The purpose of this chapter is to review literature that is applicable to BYOD programs. The chapter begins by situating BYOD within the historical context of one-to-one programs and mobile devices, followed by a review of literature that supports the conceptual framework of this research.

A Brief History of Mobile Computers in Education

A program where every child has a computer is usually referred to as laptop program because each student has a laptop (Alberta Education, 2010; Barrios et al., 2004; Bird, 2009; Warschauer, 2007), or a one-to-one program because the ratio of students to laptops is one-to-one (Bebell & Kay, 2010; Bielefeldt, 2006; Dunleavy & Heinecke, 2007; Livingston, 2006). In all these programs, the core concept is that the computers are ubiquitous, that is, always available, so that teachers can incorporate them into their lessons.

From school-provided computers to bring your own laptop (BYOL). The genesis of the idea that students should have a powerful personal computer began in the 1970s in the work of Seymour Papert (1993) and Alan Kay (1972). Papert addressed the issue from the perspective of how children could create and connect to the world. One of his key contributions to the discussion was the introduction of Logo into schools. Logo was, and is, a programming language where children could program a *turtle* (a location indicator, often in the shape of a triangle) to move on the screen, which allowed them to advance from simple geometric figures to sophisticated programs. Logo originated as version of LISP, a programming language developed in the late 1950's to overcome some of the shortcomings of FORTRAN programming language, with one of the powerful features being the ability to assign one or several values to a variable (McCarthy, 1979). That ability to assign multiple values to a program variable allowed children to use features of arrays, such as having one variable contain several values, in their programming without having to learn the complexity of arrays. A computer that ran Logo only needed a keyboard for typing commands, and a monitor for viewing the work and the results. Papert did not see Logo as a goal, but as an aide to exploration.

Alan Kay, at that time with the Xerox Palo Alto Research Center (PARC), conceived of the idea of making the computer portable so that it could be ubiquitous, and his initial sketches (Kay, 1972) and mockup (Kay & Goldberg, 1977) of the *DynaBook* look similar to current tablet devices, albeit with a

keyboard. If the screen/keyboard junction were hinged so that the screen folded to cover the keyboard, the DynaBook would look like laptops in use from the early 1990's. At the time, they projected that according to Moore's Law, a rule of thumb often used to indirectly project that processing power for a given size of integrated circuit chip will double every 18 months (Kanellos, 2003), the necessary processing power and hardware would be available in about twenty years. The DynaBook concept included a graphical user interface controlled by a mouse. PARC had developed the mouse and graphical user interfaces, which were the elements that were later licensed to Apple computer for inclusion in the original Macintosh computer.

However, Kay, undeterred by the limited technology of the day or the long projected time for suitable portable technology, developed a prototype to test DynaBook functions and installed several in a local junior high school. The computers were minicomputers with a processing unit and disk system about the size of a small file cabinet, but they did have a graphical user interface. Like Papert, Kay envisioned that programming would be a key tool for students to discover and explore, although his focus was the programming language Smalltalk (Goldberg & Kay, 1977). Even then the benefits of using such devices were starting to be known, as Kay wrote, "It is now within the reach of current technology to give all the Beths and their dads [characters in the vignette] a 'DynaBook' to use anytime, anywhere as they may wish" (Kay, 1972, p. 3).

Apple Computer launched the Apple Classroom of Tomorrow (ACOT) in 1985, with the goal of exploring integration of technology in the classroom. While technically not a laptop program as students used either Apple IIE or Apple Macintosh desktop computers, the students and teachers were provided with a desktop at school and a desktop at home in a one-to-one approach (Sandholtz, Ringstaff, & Dwyer, 1997). In this way the program shared a key feature of later laptop programs: Students had home and near ubiquitous school access, even if the computers were in fixed locations. In a departure from the work of Papert and Kay, the focus was no longer on students learning to program but on using

the computers for whatever the teacher deemed appropriate. Student achievement measured through standardized tests did not increase, but neither did it decrease. Since computers were new to both teachers and students, they needed extra time learn how to use the machines and then to use them for learning school content. In effect, the no difference finding implies that the students learned faster with the computers but used the time saved for the development of new technical skills, which were not tested. Among significant findings in the project, the researchers found that computers in the classroom could transform how some teachers taught, yet that transformation did not apply to all teachers. They also found that many teachers began to move from teacher-directed instruction to more student-centered learning. A key result of the project was the development of the model of five stages of instructional evolution of entry, adoption, adaptation, evolution, and invention (Sandholtz et al., 1997). Variations of the model are still used to evaluate technology integration and one-to-one programs (Cavanaugh & Dawson, 2010; Windschitl & Sahl, 2002).

The first documented laptop program began in early 1990 at Methodist Ladies College in Melbourne, Australia, when the school issued laptops to all students in grades five through twelve (Johnstone, 2003). Then, users exchanged information between laptops using floppy disk storage media. Shortly after, networking improvements and the Internet made the floppy disk less important, with Apple computer electing to omit the floppy disk on some of its computers in 1998 (Gore & Epler, 1998). The innovation of providing laptops to students diffused to more schools, coinciding with these improvements in networking. The state of Maine implemented one of the largest one-to-one programs in 2002, when the Maine Learning Technology Initiative began with the initial goal of providing Internet-connected laptops to all the state's seventh and eighth grade students (Silvernail & Lane, 2004). Nicholas Negroponte began his One Laptop per Child (OLPC) program in 2005 with the aim of providing laptops to all the world's poor children. Unlike prior one-to-one programs where the school or parents

would provide the laptops, Negroponte envisioned a country-wide model where the government purchased the laptops and distributed them directly to all students (Warschauer & Ames, 2010).

All the original one-to-one programs, except for the OLPC, were developed with the idea that the school would either own the laptops or, if the parents purchased the laptops, that the school would specify the laptop model and installed software. None of the programs were developed in such a way as to allow students to bring their own laptops or computers. However, the Harker School in California, began to do just that in the early part of the 21st century as they required students to bring their own computer, referring to it at the time as the *y'all come* model to mean that students were to come to school with whatever they had (Hudkins, 2005). While the school required students to provide their own laptop, it did not need to be a specified model, or even run a particular operating system. Over time, programs where students brought their own device became known as Bring Your Own Device (BYOD), Bring Your Own Technology (BYOT), or Bring Your Own Laptop (BYOL).

From mobiles to BYOD. At the time of the planning and pilot for the Bring Your Own Laptop program mentioned in Chapter One, forecasts of technology use in education predicted increased use of mobile devices (Johnson, Smith, Levine, & Haywood, 2010; Lowendahl et al., 2009). The term *mobile device* in this context were Internet-enabled feature phones (mobile phones that could access the Internet) and the then-relatively-new smartphone (mobile phones with a touch screen, downloadable applications to customize the phone, and high speed Internet access). One of the organizations predicting increased use of mobile devices was The New Media Corporation (NMC) through its Horizon Project.

This NMC Horizon Project, started in 2002, recruited educational technologists and other experts from around the world to create the forecast (Johnson, Adams, & Cummins, 2012). Martin et al. (2011) conducted a meta-analysis of the forecasts in the report through 2010, part of which included defining and matching keywords across the years. The closest concept to the portability implied in BYOD

was the keyword *mobiles*. The focus on mobiles in the reports was not on the concept inherent in students' bringing their own devices such as laptops, but was more focused on students having ubiquitous access to the Internet through then-current cellular technology using smaller devices like smart phones (Johnson et al., 2010; Lowendahl, 2010). Yet none of the predictions focused on pedagogy or an intentional strategy of incorporating the use of mobiles in classrooms. Rather, the focus was the access to the Internet that mobile devices allowed. While just having technology in the classroom does not mean that students or teachers will use it, or even that teachers will allow students to use it (Chen, 2008; Cuban, 1993, 2006), increased access to technology in the classroom makes it more likely to be used (Norris, Sullivan, Poirot, & Soloway, 2003).

In 2011, references in the literature shifted from the term *mobiles*, implying an individualistic, unplanned use, to the term *BYOD*, as in Bring Your Own Device, which quickly became the predominant acronym used to define an intentional strategy of incorporating student-provided mobile devices in the classroom (Lowendahl, 2011). This change happened during increasing ownership of mobile technology by teens, with a 2012 survey showing that 78% of teens had a mobile phone, with 37% of all teens owning a smartphone, and quarter of all teens owning tablet computer (Madden et al., 2013). BYOD was first mentioned as part of mobile computing in the *Horizon Report* for 2012 (Johnson et al.) and 2013 (Johnson, Adams Becker, Cummins, Estrada, & Freeman), while the reports for 2014 (Johnson, Adams Becker, Estrada, & Freeman) and 2015 (Johnson, Adams Becker, Estrada, & Freeman) had a separate category for BYOD. In all four reports, BYOD was listed as part of the near term horizon, that is, technologies likely to be adopted within the twelve months. Like the BYOL program described in an earlier chapter, BYOD implies that the devices are not specified by the school except in the broad generic terms, e.g., smartphone or laptop rather than iPhone or MacBook Air.

BYOD is not just a K-12 or education issue as companies and other organizations are now permitting or encouraging employees to bring their own devices. With the increased availability and

power of mobile devices, corporations are having to address network security and develop policies for employees who bring their own devices (Willis, 2012).

BYOD as a one-to-one program. Most of the discussion around BYOD currently focuses on handheld or small mobile devices, such as mobile phones or iPads. However, schools are now starting to implement BYOD programs as laptop programs where students bring their own laptop. In independent schools, all students may be required to bring such a device, with the school arranging for donations of equivalent devices for those who cannot afford one, as in the BYOL project in Chapter One. In some public schools as well, students were asked to bring laptops, with the school using laptops from existing mobile labs for those students who could not afford a device. In that case, the school laptops often remained at school (C. Harrod, personal communication, April 29, 2011). The changes in the personal computer market that resulted in more powerful, lighter computers with a touch interface have made *laptop* an imprecise term.

Conceptual Framework Overview

Not finding any well-developed theories of BYOD implementation in the literature research, the following conceptual framework evolved out of the readings and then was used to organize the discussion of the findings. In considering the success or failure of BYOD programs as well as critical issues that evolve in the implementation process, I propose a framework to explore three overlapping dimensions (Figure 3).

Framework Dimensions:

- 1: Teachers' use of digital technology for their professional work and for instruction.
- 2: Student access to digital technology.
- 3: Student ability to use their devices for learning in school.

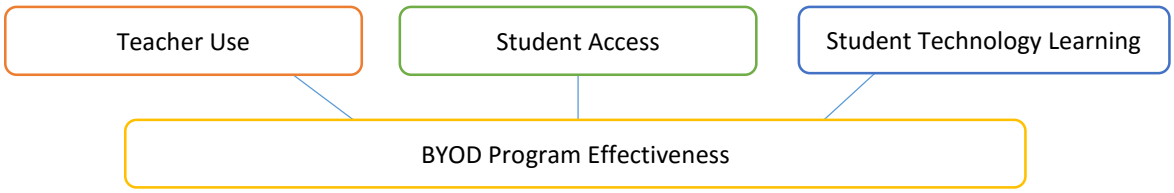

Figure 3. Conceptual framework dimensions' relationship to BYOD program effectiveness.

The relevant literature that provides support for each framework dimension is organized in the following sections.

Dimension 1: Teachers' Use of Digital Technology

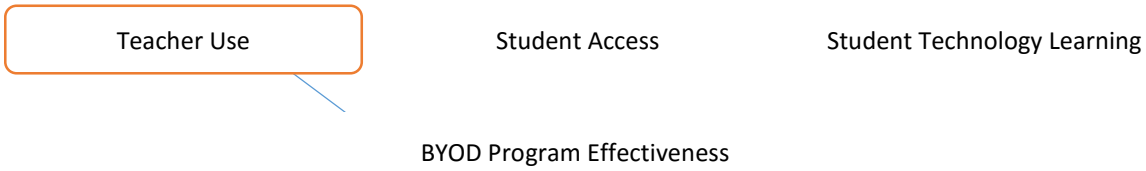

Figure 4. Dimension 1: Teachers' use of digital technology.

Teacher use of digital technology for instructional and professional uses is affected by their beliefs and barriers that they encounter when trying to use technology for these purposes. Beliefs can be changed with effective professional development. This section on teachers' use of digital technology will review literature that examines (a) teacher beliefs, (b) teacher professional development, and (c) barriers teachers face when using technology in schools.

Teacher beliefs. In classrooms that become BYOD classrooms, teacher beliefs about technology and pedagogy may tend to guide the way teachers integrate the devices in their instructional practice and the extent they allow students to use them (Churchill, 2006; Petko, 2012; Voogt, 2010). However, computers and technology offer many ways that teachers with various pedagogical beliefs can use the technology with their students in ways consistent with their own beliefs (Tondeur et al., 2008). Teachers may choose to supplement, extend, or morph the curriculum, depending on their beliefs (Ertmer, 1999; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). Supplementing happens when teachers use the technology to replace an existing activity, such as replacing math worksheets with a

software program that drills students in math. Extension happens when a teacher has students use the technology to bring extra information, such as external data sets, into the classroom while still following the curriculum. Morphing happens when the teacher transforms the curriculum to take advantage of the additional affordances of the technology.

Students benefit from collaborating, from engaging in authentic environments, and from being engaged in their own learning (Voogt et al., 2011), which, when implemented in a classroom, frames constructivist pedagogical practice. In a constructivist practice, students collaborate, create, and solve authentic problems together, and hence construct their own knowledge (Becker & Riel, 2000). From earlier research on computers in classrooms, teachers who use computers in the classroom often change to a more constructivist pedagogical practice over time and teachers who transition to constructivist beliefs tend to also be effective computer users (Tondeur et al., 2008). Teachers who "experiment, implement, and refine" the ways they use technology with students also appeared to engage in more student-centered practices and more authentic work (Ertmer et al., 2012, p. 431).

Having access to technology is not enough to change a teacher's beliefs to reflect more constructivist attitudes (Windschitl & Sahl, 2002). Furthermore, teachers' confidence in their abilities to use technology is not indicative of constructivist beliefs or actions (Prestridge, 2012), as teachers tend use technology to support their existing beliefs about teaching (Ertmer et al., 2012). Even teachers who have student centered beliefs about teaching may not use technology in the classroom in a way that exhibits those beliefs as the teachers may have barriers that make it difficult for them to use technology to support their beliefs (Sandholtz et al., 1997). Limited access is one barrier that may keep teachers from using technology to support their beliefs (Ertmer et al., 2012).

Teachers who voluntarily implement technology in their classrooms are also more likely to be willing to change their approach to effectively incorporate technology, and are more likely to be

professionally engaged and more collaborative teachers (Riel & Becker, 2008). These teachers may prove to be very effective in leading BYOD implementation in their schools.

Furthermore, Tondeur et al. (2008) found that not only do teacher beliefs affect and guide teacher technology use in the classroom, but that teachers who score high in both constructivist beliefs and teacher-directed (traditionalist beliefs) tend to use technology more with students. The authors speculated that this might be due to teachers having a wider range of beliefs to draw from.

Teachers can report technology use on a survey and they might all agree with each other that they are using that particular technology, but how they are using the technology can vary widely, with some potentially barely using the technology and others innovating uses for the technology (Hall, 2010). Even the concept of use varies, with one possibly apocryphal story relating that when personal computers were first introduced to a group of ten university faculty members with the request to "explore ways to use them" an art department faculty member proceeded to disassemble the machine and hang it as a mobile (Hall, 2010, p. 238).

With students, teachers in the same school can use the available technology resources for quite different approaches, from replacement of existing activities, such as using laptop computers to word process assignments rather than hand writing, to extending and changing the curriculum by trying to integrate the technology into all lessons and activities (Donovan et al., 2007). Similarly, one teacher in a BYOD school may do little integration with the technology even though students have it with them, and another may be pushing the limits of all the students' devices and asking students to bring in more devices if they have them. These differing approaches also affect opportunity equity for students in those classes.

Technology integration in the classroom is an innovation and BYOD is one manifestation of that innovation. The way in which innovations are recognized and adopted by more people or organizations over time is *diffusion of innovation*. Diffusion of innovation, Rogers (2003) is usually illustrated with an S-

shaped curve that shows total innovation adoption as a function of time. The curve is S-shaped, in that a new innovation is first taken up by innovators, then early adopters. During this beginning period, there is only limited diffusion of the innovation over time (the bottom of the S). As time goes on and the innovation diffuses, adoption reaches a critical point where diffusion becomes much more rapid as the majority of potential users adopt the (the rising spine of the S). As innovation adoption approaches saturation, the diffusion rate decreases, yielding an almost horizontal diffusion curve (the top of the S) as laggards slowly adopt the innovation. At the top of the S curve, the innovation is relatively stable until it is replaced by a new innovation. This classic innovation diffusion curve was developed around innovations that changed little as they diffused.

Technology diffusion is different from the classic concept of diffusion in that technology is an umbrella term that encompasses numerous innovations. As the capabilities inherent in technology change, new innovations can arise at any time and interrupt or supplant that adoption of another technological innovation (Hall, 2010). BYOD, where students bring their own technology to school, is an innovation in itself, but the very devices that students may bring were innovations at one time, e.g., smart phones, laptops, iPads. During a BYOD implementation, students may arrive with a new innovative device at any time that has sufficiently new and improved affordances that it disrupts how existing devices are used in the classroom. The possible effect is that a new innovation adoption cycle starts in the class or in the school.

Teacher professional development. Teacher professional development can help teachers develop skills using digital technologies and improving teacher knowledge of technology use can improve their ability to integrate the technology in the classroom (Harris & Hofer, 2011). However, the update model of professional development, where the goal is to update teachers with the latest information in their field, is only minimally effective (Nowlen, 1988) and professional development

opportunities that are focused on showing teachers how to use various technology tools also have only limited effectiveness (Harris, Mishra, & Koehler, 2009).

A BYOD environment may be sufficiently different from a teacher's existing environment that making full use of that environment may require teachers to change their beliefs and practice. For example, teachers who decide to allow students to use their personal devices in class may find their beliefs about teaching content challenged when their students can now just search for facts on the Internet.

Prior research suggested several areas professional development should address to help teachers change their practice: help teachers develop expertise in their subject as well as in the pedagogy of their subject; embed actual classroom examples; embed the professional development within teacher practice rather than as a demonstration; help teachers own their practice by developing collaboration with experts and peers; do so in the context of teacher professional and pedagogical objectives; and provide support and professional development over time rather than as a "drive by" (Voogt et al., 2011, p. 1235). This suggests that professional development involving BYOD, if teachers are to change practice, requires time, resources, and support. Just as having access to technology does not alone change a teacher's belief to reflect more constructivist attitudes (Windschitl & Sahl, 2002), just having students bring their own devices does not mean that teachers will incorporate the devices in their practice.

Self-reflection is important in helping teachers change their lessons in the short term and change their teaching in the long term. Self-reflection can change a teacher's practice as such reflection affects beliefs that guide tactics and strategy (Hall & Smith, 2006). This implies that professional development opportunities for teachers implementing BYOD programs should incorporate reflection. Incorporation may include helping teachers who are not familiar or comfortable with reflection develop reflection actions that work for them, and creating time that is specifically identified as being for

reflection. Action research, where teachers purposefully identify an issue, then follow a defined process that incorporates reflection, can be an effective approach for affecting teacher beliefs (The National Academy of Education Committee on Teacher Education, Darling-Hammond, & Baratz-Snowden, 2007). Expanding teacher's actions from reflection to action research, where teachers problematize their BYOD implementation, may not only affect the beliefs of the teachers participating, but bring wider benefits to the schools as action research

However, offering professional development to help teachers change their beliefs and practice does not mean teachers will take advantage of the professional development opportunity. Even when workshops are held during school hours, it is not easy to get teachers to attend (Rosaen & Hobson, 2007), which is another barrier to overcome.

How teachers learn to integrate technology in a BYOD classroom has not been the subject of much research. One way of examining teacher integration of technology is to examine teacher lesson plans and map their lesson plans against some measure of technology integration, such as the Technology Integration Matrix (Cavanaugh & Dawson, 2010). However, even when lesson plans are collected, experienced teachers write much less than novice teachers as experienced teachers tend to do more planning *in the head* yet are much better at anticipating key problems in either student understanding or student behavior; having a mental plan of how to address those problems when they do occur; and modifying a lesson on the fly to address those problems (Hall & Smith, 2006).

As a result, written lesson plans might not reveal the depth of integration that actually happens in the classroom, and classroom observations or interviews may yield more robust results (Cavanaugh, Dawson, & Ritzhaupt, 2011). Formal written plans can even have the undesirable effect of stifling creativity as teachers tend to focus more on following the plan instead of adjusting the plan based on how effective it appears to be with the students (Hall & Smith, 2006).

With the innovation of BYOD, using lessons plans as a proxy for how teachers incorporate the devices into their lessons may yield inaccurate results, and asking for teachers to create formal written plans may tend to reduce teacher innovation during the lesson, again yielding research results that do not match practice. Administrators working with teachers to implement a BYOD program should consider the affect that asking for written lesson plans may have on the innovation; they may inadvertently create a barrier. Research on BYOD implementation using teacher lesson plans my only capture the planning and miss the richness that occurs in the classroom.

Implementing a BYOD program, or any new program of teaching, typically requires schools to determine ways to create effective professional learning opportunities for teachers. As with other professions, teachers in a school are in a local community of practice where professional learning occurs. However, learning that happens in a community of practice is not automatically effective, or even useful (Lave & Wenger, 1991). Learning communities—intentional collaborative communities of the educators in a school—focus on continuous improvement of teacher practice in service of the principle that all students will learn (Lieberman, 2009). Schools can help the communities of practice potentially become more effective by helping the teachers adopt some of the benefits of a learning community.

In one approach to professional development, Koehler and Mishra (2005) proposed a form of learning communities, called *communities of designers*, where teachers would employ the principals of design as means of professional development (Mishra, Koehler, & Zhao, 2007a). When working as communities of designers, teachers identify authentic pedagogical problems, then develop and implement solutions (*products*) to solve these authentic problems. Design is the interwoven interactions among the participants, their tools, the goal, and the context in which they are creating and producing these *products* (Anagnostopoulos, Brass, & Subedi, 2007). Koehler and Mishra (2005) referred to the process as *learning technology by design*.

When a design effort begins, members of the community of designers usually know little about the technology they will need to create the product. Instead, effective design requires technology support personnel available when teachers need help with unfamiliar tasks, such as video streaming or creating a database to support learning. The goal of the technology support personnel is to help the teachers do the tasks, not do the tasks for the teachers. If the technology support personnel transition from providing support and assistance to actually doing part of the work, the teachers fail to learn the everyday part of what they are working on. Instead, technology support personnel should work on technical aspects, such as configuring video streaming, and only consulting on other tasks (Burns & Koziol, 2007). In BYOD environments, such technology support might include solving networking issues or configuring the databases in the school to automatically enroll students in an online collaborative system that teachers select.

Teachers who engage in design are using their own environments and own practice as a test bed for becoming better teachers as they design products for use with their students. Such design is not a lonely process, but also involves teachers working and exploring with each other, which begins to approach knowledge *of* practice, where teachers use what they have learned from experts outside the field of teaching, master teachers, and investigating their practice with other teachers in order to improve their own practice (Cochran-Smith & Lytle, 1999). However, in professional development where teachers are engaged in design, providing a structure or framework to help guide the teachers, who are also now learners, through the design is more helpful than just turning them loose on an assignment (Voogt et al., 2011). In a BYOD environment, such a framework might start with teachers choosing something they want to investigate that would be enabled by students having devices in their class. (An example might be in a humanities class where a teacher wants to focus on writing and peer editing where the teacher or peers can look at the work in progress at any time and comment on it.) The framework then has a process where teachers get the technology support they need to design a

solution. At specified times in the process, all teachers to share their progress, challenges, and successes with each other.

A companion for communities of designers are technology-leader communities of practice, where an expert trains a subset of teachers in a school to be technology leaders and provides them with the tools to maintain and expand an effective community of practice (Kopcha, 2010). Both approaches have the potential to provide the collegial support that is important for teachers (Sandholtz et al., 1997).

Voogt and colleagues (2011), in their meta-study of teacher collaboration examined professional development in the context of what they termed *Teacher Design Teams*, or TDTs. The objective of the study was to determine effective professional development practices that lead to teacher learning and change. They came up with four practices that help design teams be effective:

- TDTs need to implement their design so as to gain experience and improve their design based on what they learned;
- TDTs enhance the community of practice as teachers become more connected to their peers;
- TDTs should use an external facilitator as that can help channel the team and avoid pitfalls and pettiness that can happen in teams; and
- TDTs should assure that all participants on the team understand the goal of the design.

Teacher Design Teams have many of the key features of the communities of designers as explained by Mishra et al. (2007a). Reports by various university faculty members in such communities of designers involved in authentic design projects where the teams set the design goal (Mishra, Koehler, & Zhao, 2007b) showed that the communities of designers usually engaged in the effective practices given by Voogt et al. (2011), although the communities of designers seldom followed the recommended practice of using an external facilitator. Even without an external facilitator, one team did report that, in spite of some unresolved differences about the nature their literacy design, they successfully created

knowledge and a viable design (Anagnostopoulos et al., 2007). Another design team, also without a facilitator, had the design process itself challenge their preconceptions and beliefs about teaching and learning as they labored to create a problem-based learning environment. They found that their immersion in problem-based learning was successful (Dirkx, 2007). These examples suggest that facilitators are not always necessary, and teachers still have the opportunity to be successful if they can engage in the three remaining practices identified by Voogt et al. (2011).

In a BYOD environment, teachers might work as a community of designers to redesign their curriculum so as to effectively incorporate the student devices in the teaching and learning. Following the four practices for Teacher Design Teams will improve the community of designers' chances of successfully transforming their curriculum. Even if the teachers in the community of designers unable to recruit a facilitator, they have a high chance of improving their practice by following the remaining three TDT practices.

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In a BYOD program, teachers become more effective at integrating the students' devices in the classroom as their understanding of the interaction of technology, pedagogy, and content knowledge improves. The way in which teachers integrate technology and their success at integrating technology can be viewed through their understanding of pedagogy, content, and technology. In the past two hundred years of teaching in the United States, a key factor in defining an effective teacher has moved from a focus on content, to a focus on pedagogy, then to a focus on pedagogy and content (Shulman, 1986). Schulman provided a brief historical overview of what had been the beliefs about what makes teachers successful in the classroom. He examined teacher qualification examinations from the latter

half of the 19th century, which showed mostly an emphasis on teachers' understanding of content, with most of the questions being content-based. He validated this conception against diaries from the era showing that teachers did indeed take qualifying examinations that were more focused on content. He contrasted this with the research practice that had arisen since the middle of the 20th century to examine the success of a teachers' practice by emphasizing pedagogy with only a minimal consideration of content.

Shulman suggested that the focus on pedagogy overlooked how a teacher's content knowledge helped shaped their pedagogy and contributed to the success of the students. He maintained that pedagogy alone was not enough, and that content alone was not enough. Instead, more effective teaching arose from the overlap between pedagogy and content. He termed this Pedagogical Content Knowledge, or PCK. An example of PCK is a math teacher's understanding of the common errors students might make and knowing how to help students identify and correct those errors. His observations led to more educational research focus on the interplay between content, content understanding, and teaching strategies for a given content.

As technology became available in schools and classrooms, proponents and researchers were frequently optimistically biased towards the belief that technology in school was beneficial (Aagaard, 2016), while others raised the issue of teachers not using the available technology, poor professional development intended to help teachers learn to integrate technology in their classes, and lack of effect on students, particularly given the high cost of technology (Cuban, 2001). In an effort to develop a framework to help guide improvements in teacher use of technology in the classroom and address the issues of poor technology professional development and lack of student effect, Mishra and Koehler built on Shulman's (1986) conception of pedagogical content knowledge and incorporated technology as a third knowledge. Specifically, they envisioned an overlap of a teacher's knowledge of technology, pedagogy, and content, or technological pedagogical content knowledge (TPCK; Mishra & Koehler,

2006). By emphasizing the necessity of teachers knowing how to use technology to teach content, their model helped explain why much traditional technology professional development, often focused on imparting the skill of how to use a particular technology and not on its use for teaching content, did little to improve teacher use of technology for teaching (Harris et al., 2009).

As the concept became known, the name changed to emphasize that not only are technological knowledge, pedagogical knowledge, and content knowledge indispensable, integrating technology into learning requires that the teacher work in the union of the three concepts. As such, the acronym became TPACK, as in Technological, Pedagogical and Content knowledge (Thompson & Mishra, 2007-2008).

The concept of TPACK is illustrated as a Venn diagram showing the various intersection of the concepts (Figure 5). The central area, TPACK, illustrates how a teacher's understanding of the interactions among all three types of knowledge contribute to the success of teaching. Technological Pedagogical Content Knowledge (TPACK) relates to how technologies, in general, can be used in teaching. Pedagogical Content Knowledge (PCK) is Shulman's (1986) original concept of how teaching content requires knowledge of pedagogy. Technological Content Knowledge (TCK) relates to how technologies can be used to support teaching specific content (Harris & Hofer, 2011). However, while some researchers have decomposed teachers' actions, then categorized each sub-action in one of the seven dimensions represented (that is, PK, CK, TK, PCK, TCK, TPK, and TPACK; Schmidt et al., 2009), doing so does not provide useful information (P. Ertmer, personal communication, April 29, 2013).

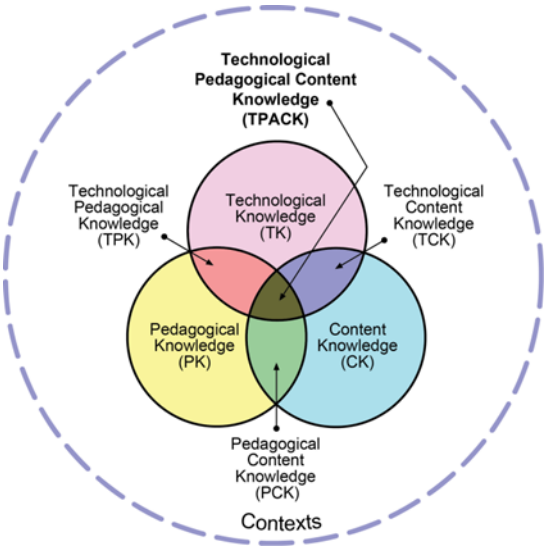

Figure 5. Image of TPACK concept. Image reproduced with permission of TPACK.org.

TPACK can be an effective heuristic to help teachers in BYOD classrooms understand how their knowledge of technology needs to be interwoven with their knowledge of pedagogy and content. In particular, it may help them understand that learning how to use a software program or some feature on the device is only technological knowledge (TK). The teachers' understanding of how technological knowledge and skill interacts with pedagogy and content knowledge and skills may help them shift their focus from the belief that a teacher must but a technological expert to the belief that the teacher should be the expert who knows how to use technology for teaching content.

Technology integration barriers. Teachers face barriers in most of the work that they do and those barriers affect how teachers use technology. Such barriers to the use of technology in schools and classes may reduce the effectiveness of any BYOD program unless schools specifically plan to address them.

Ertmer examined decisions, actions, and circumstance that hampered a teachers' ability to use technology with students or for professional purposes. An example could be a decision by the building administrator, such as keeping computers in a locked room and requiring teachers to check out a key, or it could be poorly maintained computers that teachers view as unreliable and hence do not use. Barriers are not necessarily extrinsic to the teacher. They can also be intrinsic, such as a teacher who lacks confidence with using the technology, or a teacher who does not believe that using technology

enhances student learning. Ertmer classified those barriers into first-order and second order barriers (Ertmer, 1999).

First order barriers are extrinsic to the teacher. Anything that hinders the ability of the teacher to teach that is not under the control of the teacher is a first order barrier. For example, the requirements of record keeping are barriers to spending time with children (Ertmer, 2005). An unsupportive or only nominally supportive administrator can be a barrier to maintaining an appropriate learning environment through an acceptable level of discipline (Borko & Shavelson, 1990). The length of a class period can prevent a teacher from pursuing longer collaborative times in class (Hew & Brush, 2007).

For technology in schools, first order barriers can be lack of technology in the school, an administration that keeps technology use at a low priority, a lack of technology professional development opportunities (Ertmer, 1999) or, in programs with mobile devices, short running time on batteries or inadequate wireless in the school (Bielefeldt, 2006). When the school provides all the technology for students, first order barriers can include access, where teachers either physically do not have access to technology to use with their students, or some portion of the technology is restricted, such as school Internet filters that prevent access to needed sites, or some of the technology does not work or is failure prone, resulting in lost time for students or disruption in the classroom. When access is not an issue, lack of professional development opportunities can be a barrier that prevents more use.

Second order barriers are intrinsic to the teacher, and are beliefs and attitudes that hinders a teacher's ability to teach. T\Changing those barriers requires changing beliefs. Such barriers can be teacher beliefs about how technology should be used for teaching and learning, pedagogical beliefs or personal confidence in using technology (Ertmer & Ottenbreit-Leftwich, 2010; Ertmer et al., 2012). As first order barriers are extrinsic to the teacher, lowering a first order barrier my reveal a second order barrier. This can happen, for example, when schedules are revised so that a teacher can have more time

to use the available technology, but the teacher may use then only use the available technology for drilling students with instructional software rather than having students use the technology to create, collaborate, and share.

As second order barriers are internal to the teacher, lowering them takes time and professional development. When implementing BYOD programs, schools should not expect rapid change in their teachers' beliefs about the efficacy of technology, nor should schools expect rapid change in teachers' practice.

Available resources were the most frequently mentioned barrier to technology use (Hew & Brush, 2007). Lack of access to the technology, whether because of competing for the same resources with other teachers (Zhao, Pugh, Sheldon, & Byers, 2002) or because of the hierarchical order created by the cultures of technology-using teachers and non-technology using teachers (Selwyn, 1999) were key. In this instance, implementation of a BYOD program might act to lower barriers by making technology resources more common. However, technical support becomes another barrier if the number of technology support personnel required to take care of that equipment is inadequate (Lai, Trewern, & Pratt, 2002). A BYOD model where the school provides technological and troubleshooting assistance for students would presumably run into this barrier. If a school could assume that students were responsible for keeping their own technology running and did not provide support, this barrier would fall if the equipment were reliable. However, the barrier would rise again if schools required BYOD devices to install programs to connect to the school network, making the connection more complicated than what is necessary to connect in a coffee shop.

The previous literature implies that schools implementing a BYOD program not only should consider equity issues, a type of barrier itself, but they should also consider first order and second barriers to technology use and design their implementation to lower these barriers. BYOD researchers

may need to take into account barriers in the schools they are studying and be aware of possible implications on their findings.

Summary: Teacher technology use. Beliefs teachers hold about how technology should be used professionally, and for teaching and learning, can affect how teachers use technology in the classroom. Teachers who hold constructivist-compatible beliefs are more likely to use technology in meaningful ways in the classroom than teachers who use a more traditional view of learning. Professional development can help shape these beliefs so that teachers are more likely to use technology. However, professional development that engages teachers in a joint effort to design or construct an authentic environment that they will use with their students is more likely to be effective than professional development focused on teaching technology skills. Teachers also face barriers that that can make it challenging to use technology professionally or in the classrooms. Such barriers can be external to the teacher, such as lack of available technology or administrative support for using technology, or internal to the teacher, such as a belief that content is better taught without technology.

Dimension 2: Student Access to Digital Technology

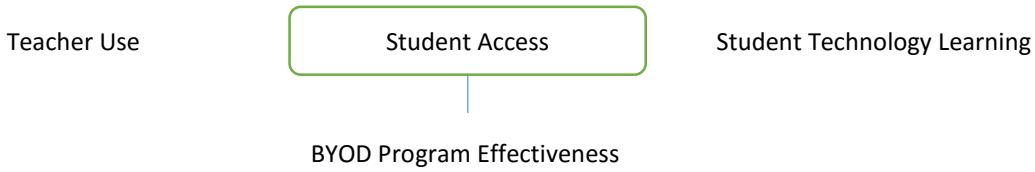

Figure 6. Dimension 2: Student access to digital technology.

Student access to digital technology is related to educational equity, one of the goals of modern education (United States Department of Education, 2013). That is, children should have the same opportunities regardless of their background. With technology, a necessary condition for educational equity requires that all children have access to appropriate funding, program, and other resources in order use technology in effective ways (Levin, 1994). Major components of equity in education are funding equity, access equity and opportunity equity. This section will review the literature on (a)

funding equity, (b) access equity, (c) opportunity equity in schools. Equity of access to technology in the homes and how this intersects with BYOD program will provide a summary of this dimension.

Funding equity. Today, most states in the U.S. attempt to fund schools in such a way as to provide equitable, not equal funding, but many states came to more equitable funding as a result of lawsuits challenging funding (Farr & Trachtenberg, 1999). The funding is a combination of local funding through property taxes and other revenues, and state aid that distributes general tax or other state revenues to districts and schools. High poverty districts receive more state and federal aid to not only offset their lower local tax revenues, but to also provide additional funding for the extra services and resources that are needed in higher poverty districts. Equity drives school funding models, where more funds flow to students and schools that need more resources, which are typically those in higher poverty areas. In the United States, the proxy for poverty rate in a school attendance area is the percent of students in a school who are classified as free and reduced lunch recipients for participation in the National School Lunch Program. The National School Lunch Program is funded by the United States Government and provides federal funds to U.S. schools to subsidize meals for students (United States Department of Agriculture Food and Nutrition Service, n.d.).

Schools with a high proportion of students living in poverty also receive federal funds under Title I of the Elementary and Secondary Education Act (Bireda, 2011). Title I funds require equitable distribution of state aid prior to receiving federal funds, but the rules guiding equitable distribution can themselves result in inequitable (Bireda, 2011; Darden & Cavendish, 2012), or even decreased (Baker & Corcoran, 2012), funding for higher poverty districts.

For BYOD, the question of equity arises if students who do not have the family or other resources to purchase equivalent equipment are receiving an equitable education. In a BYOD scenario in such a state with inequitable funding, wealthier districts would presumably have to purchase fewer devices for those who cannot afford them nor have other issues of access, further increasing the

inequities. Purchasing devices assumes that the administrators and governing boards of such districts believe that achieving equity requires that all students have access to powerful devices, have the will, and have the means to afford the devices.

However, funds expended per student does not capture the complexity and different costs for educating students at different grades, as elementary schools typically have a lower per pupil cost than high schools, but elementary schools also tend to have higher poverty levels than high schools (Baker, 2012). With higher poverty in elementary school, elementary students are likely to have less access to family-owned devices that they can bring to school and parents may be less likely to purchase expensive devices for young students. Overall, teachers in lower income schools have less access to technology for use with their students than teachers in higher income schools (Purcell et al., 2013). This implies that a BYOD program in elementary schools may require more per pupil expenditures for technology to provide access to devices for those who cannot afford them.

Even if the school decides to budget funds to provide access for all, they have the threat of budget cuts (Watters, 2012). When support is provided from the state for a statewide initiative but each school must provide supplemental funds, such as with the Maine Learning Technology Initiative (a program that provides laptops to Maine students in grades 7-12 if the schools opts in) expansion into high schools, inequity happens when only some schools opt in (Ash, 2009). Schools providing supplemental devices to students who are unable to provide their own for a BYOD program may have to cancel or reduce the program in the face of inadequate or decreasing budgets.

Access equity. When a school considers a Bring Your Own Device program it cannot ignore the issues that arise concerning equity of access to technology. However, there is not much research about the equity implications of BYOD on student access.

Some evidence suggests that school districts where BYOD is encouraged could help to increase all student access to technology. A district administrator in his blog claimed that the district BYOD

program created more equity of access in their schools. Citing his own observations and teacher reports, he reported that by the third or fourth grade, most students had their own technology, even in the low-income schools. His assumption was that parents were becoming more responsive to students' request for technology to be used for learning purposes (Clark, 2011). A 2012 national survey provides some support for his observation, where almost three-quarters of urban parents "would purchase a mobile device for their child to use at school to support learning if the school principal allowed it" (Project Tomorrow, 2013a). Another way in which BYOD programs may have helped to close the equity of access gap is that when some students brought their own devices, it reduced the competition for the often limited number of existing school-owned technology (Clark, 2011; Joyce, Akian, Farsaii, Spruill, & Tunks, 2012).

Other educators countered those observations with assumptions that BYOD will increase inequity among students. Their concern was that the differentiation in the quality of the devices that are available to different students would increase the equity divide within the classroom and created disparity in educational experiences (Stager, 2011; United States Department of Education Office of Educational Technology, 2016). Both positions—that BYOD can improve equity of access and BYOD can increase inequity—while important to consider, were not supported with data or currently available research on BYOD programs.

Schools have addressed equity in technology by providing all students in certain grades with the same device. Support for such programs can come at the state level as was the focus of the Maine Learning Technology Initiative program (Silvernail & Lane, 2004), or at the district level as was the focus Henrico County Public Schools laptop initiative for middle and high school students (Zucker & McGhee, 2005).

Addressing equity in planning any program is important as equity challenges often lead to lawsuits. Various groups may attempt to use the courts to obtain redress for equity in state aid

distributions (the funds provided by a state to its public school districts for education; Russo, 2010; Saleh, 2011), a proposition that is expensive for every organization in the lawsuit. To prevent this, schools tend to avoid taking any actions that might have a high risk of generating a lawsuit, just as universities scaled back implementation of Google Apps for Education (a free enterprise suite of applications for schools and universities that includes email, websites, productivity applications, and other features) because of lawsuits filed alleging violation of the Americans with Disabilities Act (Gagne, 2012; Quinn, 2011). Schools might avoid implementing a BYOD program in the belief that any inequity perceived by their constituents would lead to a lawsuit. When equity is viewed in terms of access to student-owned technology resources, then a program where students bring their own devices to school, such as BYOD, will need to include considerations issues of equity to reduce the likelihood of equity challenges.

However, school districts are successfully implementing optional BYOD programs without being challenged on equity (Nielsen, 2011; Schaffhauser, 2011). The districts achieve this equity by making school-purchased devices, often the laptops or tablets used as mobile labs, available to students without personal devices in the classroom. As mentioned above, BYOD as mandatory is primarily an independent school issue. Even then, equity is an issue as the schools must assure that students have access to devices with equivalent affordances.

Opportunity equity. Funding and access are not the only considerations for equity. Outwardly similar resources in different schools can have different effects on student learning, resulting in inequity based solely on which school a child attends. An example is a situation where information and communication technologies are available in schools in equal proportions. Teachers in some schools may believe that effective teaching and learning requires information and communication technology infusion and do all they can to infuse technology throughout their lessons (Ertmer & Ottenbreit-Leftwich, 2010). This belief stems from an understanding of the essential role of technology in modern

society. Teachers in other schools, even in the same district, may hold different beliefs about their students' learning, their subject area, or their own competence, that prevents them from doing more than incorporating token amounts of technology with students (Prestridge, 2012). This aspect of equity connects to framework Dimension 1 as students' opportunity to learn can be affected by their individual teachers' beliefs and practices.

Teacher and school expectations for students are a resource that can suffer disproportionately in low income and minority schools or for low income and minority students (Levin, 1994).

If a district were to implement a BYOD program, and the same proportion of students in each school were able to bring their devices, with the school providing equivalent devices to those who could not provide their own devices, equity might be served within each school. Yet, if teacher beliefs about the use of technology vary from one school the next, the time and quality of the use of the technology devices may be highly variable across the district despite the effort to provide equal access to technology.

Opportunity-to-Learn (OTL) describes the opportunity that students have in school to participate in meaningful learning (Scherff & Piazza, 2008) and OTL includes the situations, settings, and access that schools and districts create to provide equal opportunity for the students to succeed on the performance standards assessments (Elmore & Fuhrman, 1995). OTL was originally considered to be an individual issue, that is, the opportunity that each student has to learn varies from student to student. Yet in the current environment of accountability in the U.S., the drive for standards, and the rhetoric that surrounds the discussion, failing to recognize that OTL is a systems issue does not account for systemic factors that reduce OTL for certain students (Scherff & Piazza, 2008) . Such a systemic issue might occur in a school that implements a BYOD program, but makes no provision for students who cannot afford to bring a device or lacks access for other reasons. If teachers in such schools intentionally

plan for students to use their personal devices offer, but some student have no access to these devices, then the inequity in the opportunity to learn occurs.

OTL also encompasses offerings in that the opportunities offered by courses, support programs, and teacher beliefs (Ertmer & Ottenbreit-Leftwich, 2010; Mouza, 2008; Prestridge, 2012) are part of the opportunity to learn. When students are tracked, inequity usually exists between upper and lower student tracks as upper track students tend to be offered higher quality instruction, which often means more opportunity to use technology beyond drill and practice (Carbonaro, 2005). BYOD, when implemented so that every student has access, may have potential to provide more opportunities for authentic work to all students.

OTL inequity also exists when facilities and technology access differ between wealthier and poorer schools (Scherff & Piazza, 2008). In a BYOD scenario within a district comprised of a range of schools, intra-school inequities might be minimized in each school as teachers strive to assure that students have access to similar resources, but inter-school inequities might increase as more students in the wealthier schools are able to bring powerful devices, and the technology resources in the wealthier schools allow all students to have access.

Home access equity. Equity of access to devices in schools is only a part of the problem. Home access to devices and to the Internet is another issue schools face (Watters, 2012). While schools have attempted to solve home access issues, well-intentioned efforts at providing home computers and Internet access, or allowing students to check out devices, have fallen short. Examples are equipment that was old and slow, with only dial-up connections subsidized in homes with no telephone lines (Narayan & Hughes, 2012), or an unaffordable deposit was required to check out a device (Baule, 2012). Schools implementing BYOD programs will need to grapple with the equity issues implicit in widely differing student out-of-school access to powerful devices and high speed Internet connections.

Summary: Equity in BYOD implementation. BYOD programs can be structured so as to be mandatory or optional. BYOD as mandatory means that all students are required to bring a device with school-specified minimum capabilities to class and the school will provide access to those who are unable to bring such a device. In this scenario, teachers can expect all students to have access to a minimum level of technology in the classroom. BYOD as mandatory is typically an independent (non-publicly funded) school issue. BYOD as optional means that students are not required to bring their personal devices to class and, as such, teachers may not be assured that all students in a class will have access to a minimum level of technology.

Districts in wealthier areas that implement a BYOD program may have more parents who are able and willing to provide devices, whether tablet devices, laptops, smart phones, or other powerful devices, and therefore will require less funding to procure additional devices. In the United States, Title I funds help schools with higher levels of poverty but such funds are only of limited use in helping students because they are intended to keep equipment in the school. Equipment obtained using Title I funds cannot be used by non-Title I classified students if the program is a targeted assistance program rather than a school wide program (United States Department of Education, 2011).

While research on technology programs, comparing classes of students who all have access to a technology to those who do not have access, is available (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010), research on students who have differing access to technology in the same class is not available. Such differing access can take two forms: some students in a class have a device and others do not, or all students have access to a device, but some devices provide many more affordances (e.g. video editing or more effective collaboration tools). Unanswered is whether those with the higher access, whether in the device/no-device class or higher-affordance/lower-affordance class, have richer, more meaningful learning experiences. One other factor not examined is how continuing innovation in technology resulting in more capable, and usually more expensive, devices might affect equity. If a

student is able to afford the most recent powerful devices for school, what is the effect of that in the classroom? Does it effectively disadvantage other students, or do all students benefit from the presence of a more recent device? Current research does not address that question, but it may be necessary to address that question as BYOD programs become more popular.

Dimension 3: Student Ability to Learn to Use Their Devices for Learning.

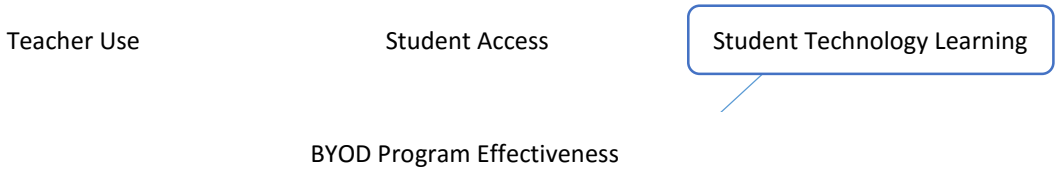

Figure 7. Dimension 3: Student ability to learn to use their devices for learning.

When students use digital technology in schools, teachers may question whether they need to teach students how to use the technology. In a BYOD environment, teachers might be concerned that they need to know how to use every device students brings.

Students can learn from each other how to use their devices, but they also need the guidance of the teacher to make full use of their devices. Students who bring their own devices into a BYOD program may not necessarily know how to use them effectively for learning, or even how to use all the features of their devices. While students can learn many ways to use their devices from each other, teachers have a responsibility to help students discover hidden affordances of their devices and help them learn to use them effectively and appropriately.

Student learning without adult intervention. Marc Prensky (2001) coined the term *digital natives* as a way to describe the apparent fluency that youths who have always had access to digital technologies appear to have with the technology, just as a native speakers have fluencies in their native languages. Several examples can be cited that suggest that natural curiosity and constructivist play is enough for young people to become competent users of technology. Sugata Mitra created the *Hole-in-the-Wall* project, where an Internet-connected computer was mounted in a brick wall near a slum in

suburban New Delhi. Students could only access the mouse, yet with no intervention, the children learned together to use the computer for Internet browsing, creating graphics, and writing documents (Mitra et al., 2005). Nicholas Negroponte of MIT Media Labs developed the One Laptop per Child (OLPC) project, where students in developing countries could be provided low-cost laptops that they could learn to operate without adult help. Not only would students learn to use the laptops themselves, Negroponte (2009) saw one of the real challenges as helping the teachers develop "enough self-confidence to let the kids show them how to use the laptops" (para. 34). Seymour Papert (1993) explained how children became proficient in using Logo as they developed their own problems, shared expertise and built on each other's knowledge. Lei and Zhao (2008) reported informal learning of computer use among students in a one-to-one laptop program. In each of these scenarios, children becoming fluent in technology through exposure and use analogous to the way they learn their native language; children learning to use computers just by exploring; children not only learning to use the technology but learning well enough to teach their teachers; and children creating their own problems and working with each other to become adept at creating programs to solve them; the common theme is children working together, exploring together, discovering together, and learning together how to use the technology, without adults teaching.

Such an approach is grounded in socio-constructivist theory as exemplified in the works of Lev Vygotsky, Jean Lave, Etienne Wenger, and others. Vygotsky's (1978) concept of Zone of Proximal Development (ZPD) defined activities and learning tasks that a child was unable to do alone but was able to do with the assistance of more capable partners. However, a ZPD can also be created when children of the same experience level are working together to solve a problem that none could solve alone—for example using technology. Each child has individual strengths that, when aggregated with the strengths of the other children, allows for success. This social learning process might account for the success that

children experienced in the Hole-in-the-Wall project, or with a low cost laptop provided as part of the OLPC project.

As children's engagement with each other expands from a single task or a few tasks to longer-term joint enterprise arising from shared interest, such as children who are active in youth clubs (e.g., boy scouts or girl scouts) or role playing games (e.g., *Dungeons and Dragons* or *Worlds of Warcraft*), they form a community of practice. Lave and Wenger (1991) examined apprenticeships, several which incorporated children or young adults as the apprentices, and from that defined the concept of communities of practice. A community of practice has a shared repertoire, mutual engagement and joint enterprise (Wenger, 1998), and a viable community of practice has a way to reproduce, that is, to continue beyond just the current group of participants (Lave & Wenger, 1991).

New arrivals to a community of practice begin by participating on the periphery of the community of practice. They are engaging in *legitimate peripheral participation* (Lave & Wenger, 1991). They learn through their interactions with other, more experienced practitioners in the community. The new arrivals, as they learn and engage more deeply in the practice, will find themselves helping other, even newer arrivals. This applies to children as well as adults. In the process of solving the naturally occurring problems, children learn. When children learn to use technology in concert with other children, their actions are similar to a community of practice in that they are mutually engaged, they are navigating a shared repertoire, which in this case would be the technology and shared resources they are using, and they are working in a joint enterprise.

Mutual engagement examples in technology are children playing an electronic game together, learning to use a drawing program together, or learning to use electronic musical instruments. Their shared repertoire consists of the shared resources (skills, knowledge, tools, methods, and approaches) they use for whatever they are trying to accomplish. In a game, the shared repertoire would include the commands, strategy, software, and simulation. If they are trying to use musical instruments on a

computer, then their shared repertoire comes down to their existing shared knowledge of music, shared knowledge of how computers work, and shared understanding of music they are trying to create. The joint enterprises in which these mutual engagements and shared repertoires exist are the various pursuits of childhood. Even in schools, the joint enterprise is school, or the individual classes, and not the subject the students study (Lave & Wenger, 1991).

In the discussions above, the assumption is that the children are working together without adult help or even adult support, yet they learn from each other. Studies of one-to-one laptop programs found that when students have laptops with them as opposed to having to use them in labs, students improved their technology skills (Argueta, Huff, Tingen, & Corn, 2011) and their ability to use the affordances of their computers to locate information (Karsenti & Collin, 2011).

Similar processes for learning have been documented in adult problem solving. For example, when two copier repair technicians were solving a difficult problem with a recalcitrant copier, they not only worked on the copier, but in the process swapped stories of other difficult copier problems they had solved, with each building on the other's efforts until they found the problem (Brown & Duguid, 2000).

Just the presence of technology in students' lives does not guarantee that students will be able to learn to use it or that that it will have a meaningful effect on their results from schools. For one study, where researchers were studying whether home computers for children improves their results in schools, the researchers identified 1123 students who did not have home computers. They randomly gave computers to half of those students to have at home as the treatment group and compared their results to the students who would not receive a home computer until the study was complete. After six months, standardized test results were compared between the two groups and the results showed no statistical difference between the groups (Fairlie & Robinson, 2013). However, the researchers intentionally did not provide any instruction or support to the students or families on how to use and set

up the computers. Furthermore, as the computers were kept in the student's homes, the students would not have had much opportunity to work with each other as was the intent of the One Laptop Per Child project (Negroponte, 2009)and the Hole-in-the-Wall project (Mitra et al., 2005). Even had the researchers provided familiarization and assistance for the work, that would have provided no assurance that the computers alone would have an effect, and might have resulted in student and parent dissatisfaction if the training computers were more capable than the ones delivered in the home (Narayan & Hughes, 2012).

Student learning through design. While the learning technology by design model created by Koehler and Mishra (2005) was developed through work with graduate students and faculty, the model has roots in socio-constructivism (Vygotsky, 1978), communities of practice (Lave & Wenger, 1991), and distributed expertise (Brown et al., 1993). With the exception of Lave and Wenger, these concepts of learning were developed almost exclusively through study of children, classroom practice, and children's learning. As for Lave and Wenger, older adolescents and young adults were among those apprenticed in all five of the apprenticeships they studied. Of those five apprenticeships, the Yucatec midwives and the Vai and Gola tailors apprenticed younger children. As these studies show, the foundational theories for learning technology by design illuminate some of the ways children learn, and do so similarly to learning technology by design. Learning technology by design should apply as well to children as it does to college students and adults.

Anagnostopoulos et al. (2007) used a design approach with high school students, finding that design effectively incorporates the interactivity of digital tools as students had to learn how to use these various tools in the authentic context of developing products that showcased the "students' own ideas, beliefs, arguments, and perspectives" (p. 100). The authors also discovered, as they engaged in their own design by developing the course, that the students also became co-designers of the course, although the authors did not go into detail about the particular practices they engaged in that allowed

students to become co-designers. In BYOD classrooms, teachers may find, as they design their curriculum to have authentic design activities that incorporate the range of devices that students are bringing, that the students become co-designers of the curriculum.

When members of a design team interact with members of other design teams (Anagnostopoulos et al., 2007) or people who work in other dimensions or communities of practice, learning can occur. Learning is enhanced as information flows between teams, whether through brokers who move among communities of practice (Wenger, 1998), or through other means of boundary crossing (Engeström, Engeström, & Kärkkäinen, 1995). Teachers also have the option of restructuring classes and the roles of the teacher and student so as to increase the likelihood that this deep learning will be supported (Brown, 1992; Collins, 1992). In a BYOD classroom, this may happen as a teacher purposefully creates collaborative design teams and encourages student to make contacts with other peers and experts outside of the class.

Student learning and technology affordances. Most technology tools, whether used by children or adults, have affordances that provide cues or clues to the user. These cues or clues, when perceived by users, support the user in completing tasks using procedures that may be unfamiliar, complex, or simply not remembered. While many of the studies cited celebrate the resourcefulness of student in directing their learning, students may benefit from the work of teachers to make visible affordances in technology with devices that might otherwise be missed

Gibson (1977) developed the concept of affordances to define how animals interact with the physical properties of the various parts of their surroundings to perform or engage in an action. Although the interaction was relative to an animal, the animal did not necessarily have to perceive the affordance before interacting with it as a “pit affords falling even when concealed by brush” (Gaver, 1991, p. 80). Affordances are relative to the action that can be taken with them, and if no possibility of action exists, an affordance does not exist (Gaver, 1991; Greeno, 1994). Gibson’s work limited the scope

of affordances to those naturally occurring and he did not distinguish humans from animals because he saw both humans and animals as natural actors. While this limited scope and lack of distinction between animals and humans led to criticism of Gibson by later authors, his research interest was not affordances but perception (Kaptelinin & Nardi, 2012).

Norman (2002) focused on human interaction and posited that humans' routine knowledge of how to operate in the world was not in the head but mostly infused in the world, and that knowledge in the world manifested to us as affordances. In Norman's meaning, affordances had to be perceivable for a person to act on them. Rather than limiting his work to naturally occurring objects as Gibson had, Norman's primary focus was on human-designed artifacts and the way such artifacts could be created so as to imply to users how to use them or the function they performed or, in his term, their perceived affordances.

While affordances were first associated with physical artifacts, the term was extended to be used to refer to objects in the graphical user interface on computers. The use of the term *affordance* was initially tied to how an object on a computer monitor evoked in the user the idea of a correspondence to a physical object, such as an onscreen button that appears similar enough to a physical button that it affords pushing (Gaver, 1991). If a person perceives that an object on the screen affords an action, the person can act on that affordance.

An object on a screen does not necessarily need to correspond to a physical object for it to offer an affordance as custom or convention can create the idea of an affordance (Norman, 2002). An example of such a custom or convention occurred during the initial creation of hypertext markup language, which is the code to create web pages for display in web browsers. The designers chose to have the then-new concept of hyperlinks signaled by underlined text (Weinreich, Obendorf, & Lamersdorf, 2001). The result offered by what merely appeared to be underlined text was, when clicked, a new page of information. As underlined text became the convention for hyperlinks, first-time Internet

browser users might not have perceived the underlined text as an affordance, but they quickly learned to click on the underlined text once they had learned that it signals the action that will happen.

An object on the screen may appear to offer an affordance when it does not, and as such is a false affordance (Gaver, 1991). An author who underlines text on a web page just for emphasis, creates a false affordance as the underline signals to the viewer that the text is a hyperlink, resulting in many readers clicking, clicking, and clicking again—and finding nothing happening.

If a portion of our knowledge is in the world and visible through perceived affordances, students learning how to use their own devices may learn to perceive various affordances and to interact with those affordances. If each interaction with the affordance produces the same result when the mapping of affordance to action is consistent, over time the mostly conscious task—see object ➔ perceive affordance or affordances ➔ interact with affordances—becomes mostly automatic (Still & Dark, 2013).

Computers and other electronic devices offer numerous affordances, but each student's ability to perceive each affordance varies from all the other students. The perceptual probability of affordance (Lu & Cheng, 2012) refers to how likely it is that most people will perceive a certain affordance. A high perceptual probability of affordance implies that a larger number of people will recognize the affordance and, conversely, a low perceptual probability of affordance implies that few, if any, people will recognize that an affordance exists. If students are working together and communicating with each other, any one student's perception of an affordance may be sufficient for all students working closely with that student to learn of the affordance. This cooperative work effectively increases the perceptual probability of an affordance and also serves as an example of the zone of proximal development (Vygotsky, 1978).

Summary: Student ability to learn to use their devices for learning. A review of the literature finds a research basis exists that implies that students should be able to learn to use their devices from each other as they engage in meaningful (to them) activities. This device learning may occur without

adults either present or implicitly teaching how to use the device. As they learn to use their device, they should be able to use it for learning.

A review of affordance theory conveys the concept that devices have affordances that lead to actions. Affordances can also be defined as knowledge infused in the world. If students perceive various affordances in their devices, regardless of whether the affordances are inherent in the hardware or software, they have access to actions available through those affordances. A student may be able to use these perceived affordances to complete unfamiliar tasks.

Summary

This brief history of mobile computers in education traced educational use from the initial idea that every student should have ubiquitous access to powerful computers in schools, to the implementation of one-to-one programs, and the potential affordances of bring your own device programs.

The researcher literature suggests that a teacher's beliefs and practices about technology guide how that teacher will incorporate the technology into instruction, and they willingness to work with student owned tools. Teacher professional development, such as that which emphasizes collaboration and requires teachers to design a product, helped change beliefs and practice over time. Teachers have faced barriers when using technology in the classroom. Some of the barriers are extrinsic to the teacher, such as low administrator support for technology or inadequate equipment, and some are internal, such a teacher's beliefs about teaching and learning. When students bring their own technology, teachers and schools have been challenged to find ways to provide technology to students who either cannot bring a device or do not have a working device on a particular day.

Implementation of BYOD programs have implications for different forms of equity. Equity of funding, access, and opportunity at school and home are elements that have shaped efforts to make instructional use of students' personal technology devices. Descriptions of the design and

implementations of BYOD programs frequently have extensive discussions of how the programs addressed the different equity challenges and barriers.

The framework was developed from the literature review and which will be used to direct the exploration of the effectiveness of BYOD programs in this research is related to the interaction among three Dimensions (Table 1).

Table 1

Conceptual Framework Dimensions

Dimension	Description
Teacher Use	Teachers' use of digital technology for their professional work and for instruction.
Student Access	Student access to digital technology.
Student Learning	Student ability to learn to use their devices for learning.

In this work, I plan to look at how each of the dimensions work together to shape the success or failure of BYOD programs in schools. The understanding gained may help school administrators and teachers create effective, equitable BYOD programs, and allow policy makers to address BYOD with research rather than conjecture or unsubstantiated belief.

Chapter 3. Methods

Research Design Overview

The purpose of this research was to understand how teachers implement a Bring Your Own Device (BYOD) program in their classroom and their perceptions of the successes, challenges, and outcomes in terms of student learning of their BYOD program. Implementation includes a focus on the technical, social and institutional challenges teachers face as they develop instructional use of student owned devices. Teachers' perceptions of the successes and challenges of their BYOD program includes their accounts of how student equity is negotiated, as well as their overall perceptions of how BYOD is enabling learning in the classroom.

This research was a mixed methods study, where "the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone" (Creswell, 2014, p. 4). The format of the study was a triangulation design that used a data transformation model, that is, quantitative and qualitative data were collected and analyzed, then the qualitative data was transformed into quantitative data in order to compare and interrelate the now-quantitative data sets (Creswell, 2014). The interpretation was based on those two data sets.

The research consisted of two instruments. The first was an anonymous online survey. Participants who completed the online survey had the opportunity to provide an email address if they agreed to be contacted for follow up with an interview, which is the second instrument. The study was parallel in that the online survey and the interviews occurred during the same data collection interval, that is, interviews with some participants were completed before other participants had started the online survey. The study was also single phase in that the research instruments were developed prior to beginning data collection rather than, as is also appropriate in mixed methods, collecting data, analyzing the result, then designing a second phase.

As the research questions are not about a particular technology, but rather about how existing technologies were implemented in classes the online survey was created using the term *digital technologies* to avoid focusing on a particular digital tool. The exceptions were when it is important to differentiate between digital tools, e.g., smart phones, tablets, and computers, and their capabilities.

The survey questions that addressed BYOD were developed specifically for this research as none of the existing research instruments used in this study specifically addressed BYOD programs.

Research Questions

Research questions in mixed methods research often include at least one or more encompassing questions that addresses the connection between the qualitative and quantitative portions of the study (Tashakkori & Creswell, 2007). Subquestions can explicitly focus on qualitative or quantitative methods. For this research, there were three main research questions with the first research question having two subquestions:

1. How is teacher incorporation of student devices in instruction related to their own beliefs and practices around the use of technology professionally and for instruction?
    - How are their practices affected by the school support for technology?
    - How are their practices influenced by the school implementation of a BYOD program?
2. To what extent do teachers perceive that BYOD programs provide equitable access for all students?
3. To what extent do teachers perceive that students are successful in using their own technology for learning in a BYOD classroom?

These questions have been added to the framework model that is being used to organize this study (Figure 8)

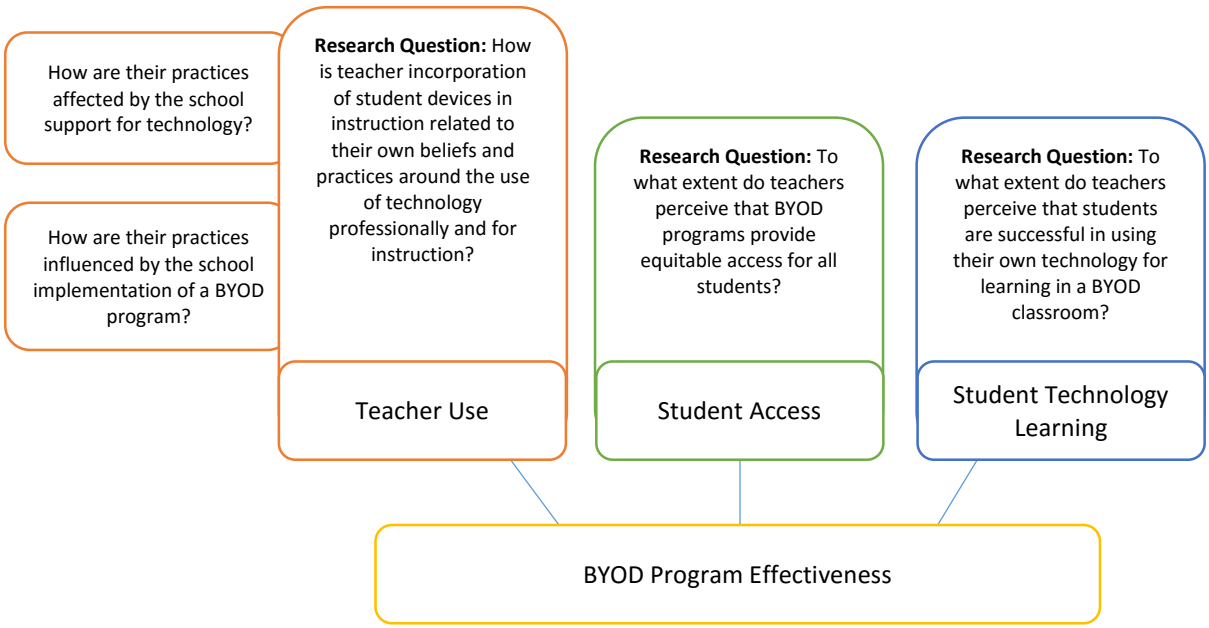

Figure 8. Relationship of research questions to conceptual framework dimensions.

Data Collection Tools

Teacher survey. The first data collection instrument was online survey of teachers with experience in BYOD classrooms (Appendix A). While BYOD is a relatively new approach for most schools, it is an extension of technology use in the classroom. As such, the survey was developed based on prior research for technology use in schools, and teachers' attitudes and beliefs towards technology. Additional questions were developed to address the unique features of BYOD, such as students using different types of technology in the classroom rather than all having uniform technology as one-to-one programs tend to have (Appendix B).

The online survey was primarily composed of quantitative questions derived from existing research: teacher's beliefs about technology and pedagogy (Johnson & McClure, 2004; Petko, 2012; Prestridge, 2012); teachers' attitudes towards technology (Knezek, Christensen, Miyashita, & Ropp, 2000; Petko, 2012; Shattuck et al., 2011); teacher professional engagement and leadership (Becker & Riel, 2000; Riel & Becker, 2008); and barriers encountered by teachers (Ertmer et al., 2012).

While many of the survey questions came from existing research instruments, some changes were needed. Most of the existing research was conducted before tablets (iPad or similar) and smartphones became ubiquitous and the terms used in the original surveys tended to exclude those devices. (*Tablets* as used in this research should not be confused with the class of electronic devices known as *Tablet PCs*, which were laptop-class computers that could be used as a standard laptop or, through a swivel mechanism built into the hinge between the keyboard and screen, could be converted to a flat form with the keyboard hidden and the screen up so the user could handwrite notes.) For example, several of the surveys had questions framed in terms of computers in the classroom e.g. (Knezek et al., 2000; Petko, 2012), whereas many schools are now using tablets. Tablets have different affordances, and it might be possible for a person who finds computers to be intimidating (Knezek et al., 2000) to find tablets to be friendly. As such, using the word *computer* in a survey to elicit participants' responses about their use of technology when they use tablets might have low construct validity, the "assessment of the degree to which a measure actually measures the latent construct it is intended to measure," (Netemeyer, Bearden, & Sharma, 2003, p. 8). Merely substituting the word *tablet* for *computer* might result in appropriate construct validity for a measure such as access to the Internet, but may have no meaning if the question is about whether the tablet is connected to the network with wires or wirelessly, as current tablets are exclusively wireless. In addition, as tablets have become more used in schools and more students are likely to have a tablet instead of, or in addition to, a laptop, the questions were modified to acknowledge the affordances of tablets, such as virtual keyboards. Appendix B shows the origin of each question.

Three experts (technology directors or teachers who have been participating in BYOD programs) were asked to evaluate the survey and they provided feedback on the structure of the survey and on survey questions.

Teacher interviews. Teacher interviews provided qualitative data that were triangulated with the quantitative data from the teacher surveys. Interview participants had taken the survey as the form to volunteer only appeared after the survey was complete. The goal of the interviews was to elicit additional information that might not be revealed through the survey. The full interview protocol is in Appendix C.

Data Collection Strategies

Sources of data. Data came from two sources. The first source was the primarily quantitative online survey that participants completed (Appendix A). The second source was the interviews of participants who volunteer for an interview (Appendix C). They could volunteer to participate in an interview after they completed the online survey or they could volunteer without completing a survey.

While surveys of teachers are well-established and have good construct validity, BYOD is sufficiently recent that surveys that capture some of the nuances, such as how equity looks, how teachers accommodate the devices in their classroom, or how teachers perceive that students learn to use the devices, is less well understood. The interviews acquired qualitative data that could be triangulated with the data from the online surveys.

The interview protocol was semi-structured with key prompts to assure consistency between interviews. However, during the interview, the interviewer asked additional questions based on the information the participant provided.

The key prompts are shown in Table 2, with the numbers in parenthesis indicating which research question the prompt was intended to address.

Recruiting participants. Participants were recruited for this study through several different procedures. Information was posted in online discussions and blogs where classroom teachers using BYOD were likely to see it. A public registry of schools, primarily in Australia, which participated in BYOD programs in 2012, was developed by one school to help those classrooms to connect with each other.

This registry was used to contact these schools. To increase the number of survey responses, LinkedIn (an online social networking site for professionals) members who participated in a discussion on BYOD programs and who had identified their classes, schools or districts as participating in BYOD programs were contacted and asked to participate. Other public forums were used as well as published news articles about schools implementing BYOD. Information and recruitment messages are shown in Appendix D.

Table 2

Relationship Between Interview Prompts and Research Questions (RQ)

Interview Prompt	RQ 1	RQ 2	RQ 3
Can you tell me of an experience or experiences where you thought having BYOD in your classroom was really effective?	x	x	x
What are some of your favorite digital tools or programs you use with your students when they use BYOD?	x		
Can you tell me of an experience or experiences where you thought having BYOD in your classroom was ineffective?	x	x	x
What happens if you have a student who is unable to bring a device?		x	
What challenges have you had or continue to have while trying to implement BYOD?	x	x	x
Can you tell me about any relationship between BYOD in your school and equity among students?	x		x
How do your students learn to use their devices effectively for learning?		x	
Is there anything else you would like to tell me about BYOD or using digital technologies in your school that we may not have covered?			x
Total prompts for each question	5	5	5

The educators who completed the registry or participated in the LinkedIn discussion were primarily school or district level administrators, but this research is intended to examine teacher

practice in the classroom. These administrators were asked to forward the survey request to classroom teachers, in return for which they could register to receive a summary of the results when available.

Survey participants. Survey participants were pre-qualified before continuing to the informed consent. Pre-qualification initially consisted of asking potential participants if they were currently or had taught in a school with BYOD, and if they were currently teaching fifty percent or more in classes where students bring their own devices. If they answered no to either question, they were taken to a screen that thanked them for their interest but did not give them a link to continue with the research.

Interview participants. Interview participants were drawn primarily from survey participants who choose to be interviewed. Interviewees were selected from those who volunteered, with a goal of interviewing teachers from diverse schools and different grade levels. As such, rather than interviewing the first volunteers, potential interviewees were chosen after several participants had volunteered. In the form were participants volunteered to be interviewed, they provided their teaching responsibilities (pre-school, primary/elementary, middle school / junior high, high school, vocational / career ed.); type of school (public, independent - secular, independent - religious, public charter, international (non-North America) and other) and school location (urban, suburban, town, rural, remote, other). The three items were used when selecting interview participants from among those who had volunteered for interviews in order select a heterogeneous group of interviewees. However, due to the low response rate from the interview invitation, in practice most volunteers were extended an invitation to interview. Interviews began after several participants had volunteered for the interviews.

As survey participants were offered an incentive in the form of a donation to a charity, an outside limit of 500 surveys and 20 interviews was set. To be able to understand the relationships between the many items in the tests, the minimum goal was fifty completed surveys and eight completed interviews. The intent was to have the surveys complete within four weeks of starting the research, with interviews mostly completed by then, although school breaks and other school timing

issues affected the total time required. Interview timing depended on scheduling issues between researcher and participant.

Incentives. Offering participants an incentive to complete a survey can result in higher response rates in many cases (Birnholtz, Horn, Finholt, & Bae, 2004; Fan & Yan, 2010; Millar & Dillman, 2011). The timing of the incentive (sent unsolicited before asking for participation, sent before the participant completes the survey, or sent after the participant completes the survey) also affects the completion rate (Singer & Ye, 2013), with higher completion rates coinciding with earlier delivery of incentives (Dykema, Stevenson, Klein, Kim, & Day, 2013; Sánchez-Fernández, Muñoz-Leiva, Montoro-Ríos, & Ibáñez-Zapata, 2010). However, surveys also have higher response rates when the topic is meaningful to the participants, which also weakens the effect of the incentive (Groves, Singer, & Corning, 2000). Singer and Ye (2013) suggested that if survey designers put effort into increasing the intrinsic motivation of participants, the need for incentives could be reduced.

The introduction of the survey was written to encourage intrinsic motivation. Teachers were encouraged to share their expertise to help others who are thinking of using a BYOD program as a way to increase classroom technology. In addition, participants had the option of electing to receive a summary of results, which effectively returns some of their own effort back to them. Finally, as an inducement to those who may not quite be committed to completing the survey, participants could select from two charities to receive a small donation from the researcher for their completed survey. Interview participants could also select from the two charities to receive a small donation. Whether these incentives had an influence on the survey is difficult to assess. However, several interview participants spoke favorably of the contribution when they were asked which organization they would like a donation made to.

Internal reliability. The online survey was mostly adapted from surveys used in existing research, all of which had a minimum Cronbach's alpha of 85%. While adapting the questions could

affect the internal reliability, as part of the analysis of the survey data, the alphas of the surveys were calculated to validate the instrument. Questions that were developed to measure areas specific to this research, such as for equity perception of BYOD also needed internal reliability checks. These questions will be validated against the results of the interview portion of the research.

External reliability. External reliability and validity of the portions of the survey that were developed specifically for this research arises when untested questions are includes in the survey. As such, the online instrument will be evaluated by teachers who are engaged in BYOD, but who are not in the schools being surveyed.

Considerations of Human Subjects

This research followed the guidelines established by the National Institutes of Health and the Pepperdine Institutional Review Board for consideration of human subjects and permission was received to conduct the research (Appendix E). All research was done with adults who volunteered for the survey and who were presented with the appropriate informed consent. The survey was only accessible through an encrypted secure socket layer (SSL) connection so that responses could not be intercepted. All responses are confidential, and all data was stored on hard drives encrypted with BitLocker, a full-disk encryption technology. As part of assuring reliability and using the data in numerous locations while maintaining security, the data was backed up with SpiderOak, a zero-knowledge backup and synchronization program that encrypts and decrypts all data on the local computer before transmission so that server has no knowledge of the data or contents, and no way to extract the data as the encryption key never leaves the machine.

Interviews were conducted through Skype®, and Internet telephony application that allowed synchronous audio. Interviews were digitally recorded on an encrypted disk. Only the researcher had access to the full recorded interviews. Any potentially identifying information was elided from the audio before sending the audio for transcription.

The questions in the survey dealt with professional actions and perceptions and should not have reveal any embarrassing data. Limited personal demographic information was collected to understand the background of the teachers, but not the type that would allow for the identification of the teacher.

All participants were required to give their informed consent. For the surveys, participants agreed that they understood the informed consent before they could access the rest of the survey. For the interviews, participants were required to verbally give their informed consent before the interview continued.

Plan of Analysis

Online survey analysis. Survey questions drawn from extant instruments had been validated through the studies to show correlation between the questions and what they intended to measure, for example teacher beliefs, attitudes towards technology, or class room environment. However, questions were phrased in such a way as to reflect current technology and have meaning to a teacher in a BYOD classroom. For example, the word *computer* has only limited meaning in a classroom where students are bringing in smart phones, or tablets or other devices. Teachers in such classrooms asked about how their students use their computers might have had a difficult time answering the question. Minor changes were made to many questions, for example, modifying them to use consistent terminology, such as using the term *digital technologies* rather than the term *technology* or similar, and changing references to a particular type of device, such as *computer* to the more generic *device* to recognize the proliferation of devices. In addition, questions drawn from Petko (2012) were translated from German by this writer with the aid of Google and Microsoft translation software. Some of those included questions addressing a constructivist learning environment had previously been translated into German from English as they were adapted from a shortened, revised version of the Constructivist Learning Environment Survey (CLES), specifically the CLES 2(20), where the *20* represented the number of items

(Johnson & McClure, 2004). Appendix B shows the link of the current survey question to the original instrument.

Furthermore, some questions were created based on the results of previous research. For example, those addressing challenges that teachers faced were based on the findings of technology barriers (Ertmer et al., 2012).

The first step in analyzing the survey results was to examine the data to determine if any results should be discarded due to incompleteness.

Preparing interviews for analysis. Qualitative analysis of the data from the interviews began with transcription of the interviews. The transcriptions were checked for obvious mistakes, then sent to the interview participant so that the participant could verify that the transcription was an accurate record of the interview. Prior to detailed analysis, the interviews were "read through to obtain a general sense of the information and reflect on the overall meaning" (Creswell, 2009, p. 185).

Using a qualitative analysis program to help organize the data, the analysis generally followed steps suggested by Creswell (2009). However, rather than developing codes directly from the transcripts, the themes from the survey were used to create the *Transcript Code Book* (Appendix G) to guide coding.

The survey also had several questions that allowed for free response by the participants, but in those cases, themes were extracted from data as the questions were specific.

Triangulation. As this is a mixed methods research, the results of the online survey and the results of the qualitative interview were triangulated with each other. A data transformation approach where the qualitative data is converted to quantitative data was initially chosen as Creswell and Plano Clark (2007) suggested that converting the qualitative data to quantitative data is usually less complex than converting quantitative data to qualitative. However, the actual data guided the selection. I this case, some qualitative data—primarily the open response questions from the survey—were converted

to quantitative data, but with others a better analysis resulted from not transforming data, but rather discussing the two data sets, and showing comparisons and contrasts. The decision about the final analysis was made after preliminary analysis of the data as which technique to use to illuminate the data.

Comparing the two datasets and relating them to the research questions also allows for a checking the validity of the results.

Limitations of the study. This study has several limitations. The first is that the participants were all be volunteers for the study rather than using a random sampling technique. The second is that, because of the recruitment process to find participants, participants may be more engaged in their profession than if a random sample were used and as such the participants may report more effective use in their classrooms (Riel & Becker, 2008). Furthermore, the route chosen to recruit teachers was by contacting educators who participated in an online BYOD discussion on LinkedIn, a professional social networking sites. As those educators were primarily school or district administrators or non-classroom faculty rather than classroom teachers, they were asked to forward an introductory message to teachers asking them to participate. Educators who were willing to voluntarily participate in BYOD discussions may reflect their school's or district's interest in having a successful BYOD implementation as the message was forwarded to them, and teachers recruited through such a process may make greater use of BYOD in their classrooms than teachers who do not respond.

Summary

The purpose of this study is to determine teacher use and perceptions of the successes and challenges of BYOD programs The proposed research method was a mixed method study using a triangulation design of a data transformation model, that is, quantitative and qualitative data were be collected and analyzed, then some of the qualitative data was transformed into quantitative data in order to compare and interrelate the data sets. The quantitative data was collected through a survey of

teachers who had experience in BYOD programs. The qualitative data was primarily collected through interviews with teachers who completed the initial survey and volunteered for the interviews. As shown in figure 9, the research was guided by three research questions, each of which is associated with one of the dimensions of the conceptual framework.

1. How is teacher incorporation of student devices in instruction related to their own beliefs and practices around the use of technology professionally and for instruction?
    - How are their practices affected by the school support for technology?
    - How are their practices influenced by the school implementation of a BYOD program?
2. To what extent do teachers perceive that BYOD programs provide equitable access for all students?
3. To what extent do teachers perceive that students are successful in using their own technology for learning in a BYOD classroom?

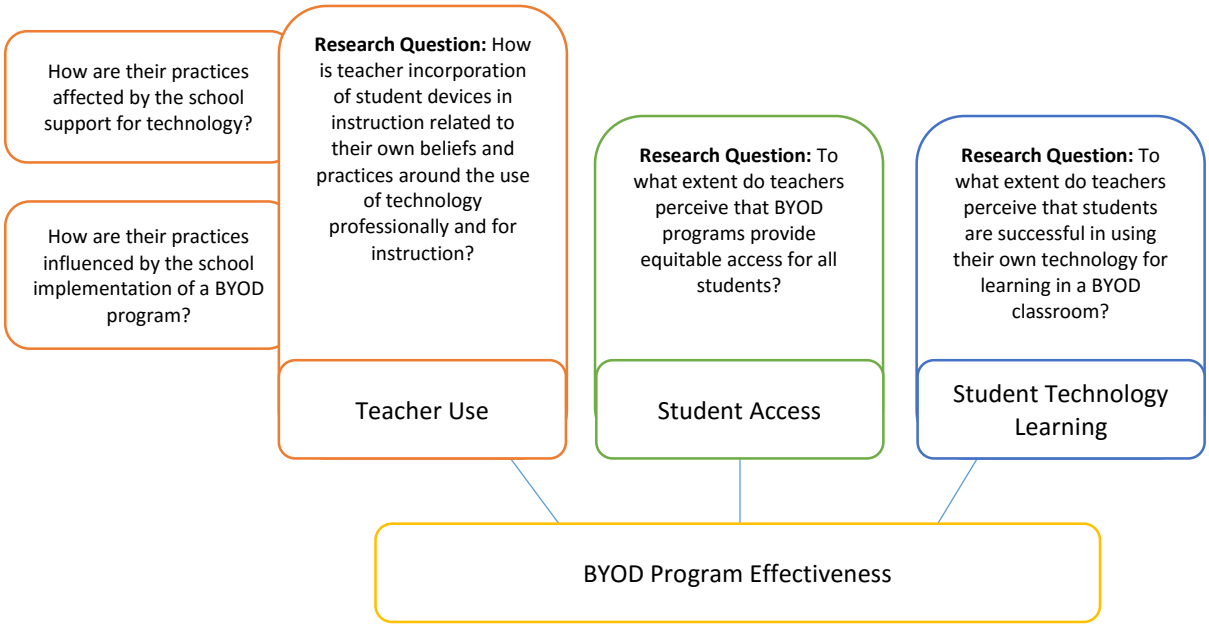

Figure 9. Relationship of research questions to conceptual framework dimensions.

Chapter 4. Results

Purpose of the Study

This study was devised to develop an understanding of how teachers in BYOD classrooms make use of student owned technology in the classroom, how they handle issues of access, and how they perceive student learning in such an environment. Student learning for this study encompassed students learning content as well as students learning to use the devices that they bring. As some students in BYOD programs might be unable, for any reason, to bring their own device, this study also included a portion that probes how schools address this lack of device access issue. Lack of access may also imply that an inherent inequity exists between students who have powerful devices compared to those who have limited-capability devices.

Research Questions

Because there was little prior research on BYOD programs, this research was exploratory in nature and used a mixed methods approach incorporating qualitative and quantitative measures (Creswell, 2014). Mixed methods research often includes one or more encompassing questions that addresses the connection between the qualitative and quantitative portions of the study (Tashakkori & Creswell, 2007). The conceptual framework provided a guide for developing research questions. For the first dimension, sub-questions were used.

For this explorative study, the emphasis was on the teacher and teacher reports of outcomes across many schools. As such, research questions were developed with teachers as the focus, with three main research questions and the first research question having two sub-questions. Each research question addressed one of the dimensions of the conceptual framework (Table 3).

Research Design Overview

The format of this mixed methods study was a triangulation design with a data transformation model, that is, quantitative and qualitative data were collected and analyzed, then the qualitative data

was transformed into quantitative data in order to compare and interrelate the now-quantitative data sets (Creswell, 2014). The study used two instruments: an anonymous online survey for primarily quantitative data collection, and a confidential interview for qualitative data. Participants who completed the online survey (the first instrument) had the opportunity to provide an email address to be contacted for follow up with an interview (the second instrument). The study was parallel in that the online survey and the interviews occurred during the same data collection interval, that is, interviews with some participants were completed before other participants had started the online survey. The study was also single phase in that the research instruments were developed prior to beginning data collection rather than, as is also appropriate in mixed methods, collecting data, analyzing the result, then designing a second phase.

Table 3

Research Questions With Mapping to Framework Dimensions

Number	Research Question	Dimension
1.	How is teacher incorporation of student devices in instruction related to their own beliefs and practices around the use of technology professionally and for instruction? • How are their practices affected by the school support for technology? • How are their practices influenced by the school implementation of a BYOD program?	Teacher Use
2.	To what extent do teachers perceive that BYOD programs provide equitable access for all students?	Student access
3.	To what extent do teachers perceive that students are successful in using their own technology for learning in a BYOD classroom?	Student technology learning

Anonymous online survey. As the research questions are not about a particular technology, but rather about how existing technologies were implemented in classes, the term *digital technologies* was used throughout the survey to avoid focusing on a particular digital tool. Exceptions were made when it

was important to differentiate between digital tools, e.g., smart phones, tablets, and computers, and their capabilities.

The survey was based on prior instruments with terms and concepts updated to reflect current digital tools and technologies. As noted in Chapter Three, existing instruments framed questions in terms of computers in the classroom (e.g., Knezek et al. [2000], and Petko [2012]), whereas many schools had begun using tablets. As tablets have different affordances from computers, perception and attitude towards them might also have been very different. Questions were therefore modified to reference technology likely to be available to the participants.

Confidential teacher interviews. Interview participants were a subset of the survey participants, who at the completion of the survey volunteered to participate in an interview. The goal of the semi-structured interviews (Appendix C) was to elicit additional information that might not be revealed through the survey. During the first interview, it became apparent that the BYOD implementation model (whether students were required to bring a certain type of device, whether the program was mandatory, etc.) was necessary to understand the context of the answers and this information was intentionally gathered as part of the demographic data for all interviews.

Recruiting participants. The participants were initially intended to be practicing teachers who currently taught, or had previously taught, a least half time in a classroom where students bring their own devices. The half-time teaching criterion was chosen based on the researcher's experience as a way to select participants who had sufficient experience with BYOD in the classroom, but there was no prior research to guide the selection of that limit.

Potential participants, or people who could provide a lead to potential participants, were identified and contacted through several methods (Appendix D). General social media messages with links to the survey were posted in Twitter (a microblogging platform) addressing #byotchat and #byod, and a discussion post to LinkedIn (a professional networking website) to the *BYOD in Education* topic

forum. A post with the survey link was also made to ISED-L, an email list of primarily independent school educators who frequently discuss technology use in the classroom.

The most messages were generated as direct email messages. A list of contacts at sixty Australian and New Zealand schools participating in BYOD was available on the Internet and each was contacted. In addition, LinkedIn members who had participated in a prior public discussion on LinkedIn were also contacted if their comments indicated they worked in a school with BYOD and had provided enough information in their public profile such that an Internet search yielded an email address for them. For that discussion, out of 1,161 unique individuals who posted from March, 2013 to December 2014, 297 of the people participating had enough information in their profile to indicate they were in a school with BYOD and had an email address that could be found through an Internet search.

However, due to the nature of LinkedIn, with a focus on professional networking through all professions, participants in the discussion on education uses of BYOD were primarily administrators, technology directors, or technology coordinators, most of whom did not teach classes. Contacts at the sixty Australian and New Zealand schools also fell into the same category. As such, the direct email encouraged them to pass the survey on to teachers at their school.

In order to supplement these sources, a customized Internet search was configured to find news stories of schools implementing BYOD. If the news story indicated that a school had experience in BYOD, as opposed to just announcing and beginning a program, and there was enough information in the story that allowed an email address to be found for a potential participant, that person was sent a direct email as well.

One of the unanticipated consequences of sending emails to potential participants and those who could help locate participants was the number of people who replied with questions or with statements about their participation. Of the 1,007 emails sent requesting participants for the online survey, 73 (approximately 7%) replied. However, a side benefit was feedback from potential

participants. In one exchange, a school technology coordinator expressed concern that the teachers in his school would not be able to participate in the study. The teachers were teaching only two or three periods a day in a BYOD environment and their school had just started the BYOD program the prior semester—his teachers would fall below the qualification required of teaching half-time in a BYOD classroom. Based on the potential participant's comments and the disqualification report, which showed about half of the potential participants were being disqualified, the threshold was lowered to one quarter (25%).

Preparing the Data for Analysis

In order to prepare the survey data for analysis, as much of the data in the survey came from items using a Likert scale, values were assigned to each of the response options in order to convert the ordinal data in the Likert scale to interval data. These values were from 1 to 5 on most of the items, with 1 being low. Then summative factors were created from associated items, where the value for the factor was the arithmetic mean of the value for each individual response item. The response items were then mapped to the summative factors (Appendix F). Open response items were also coded to identify trends and patterns, with codes derived from the survey (Appendix G).

Interview analysis. Of twelve total interviews, eleven were with teachers and one was with a schoolwide technology coordinator who did not teach, but assisted teachers with integration. The interview with the technology coordinator was used to verify the questions and understand the flow of the interview. While that interview provided useful background information, the results are not included in the coding analysis as numerous BYOD program models and trials were discussed without focusing on a particular teacher. The interview audio was a stereo recording with the interviewer on one channel and the participant on the other channel. Analysis began after eliding inadvertent identifying information from the audio, such as if the participant mentioned the name of the school. The audio was then sent to be transcribed. The transcription process omitted filled pauses (hesitation sounds), such as

uhh, *ummm*, non-lexical phenomena, e.g., laughs, coughs, and any back channel utterances that did not contribute to meaning to the dialog (e.g., *uh-huh*, *okay*, *interesting*). The interview transcript was sent to the participant, who was given an opportunity to review and submit corrections or clarifications. Of the twelve interviews, four were returned with minor corrections or clarifications.

The first part of the analysis was to get an overall sense of the data (Creswell, 2009). This was done through listening only to the participant's portion of the interview. *Audacity*, an open source audio editing program, was used to prepare the interview for listening. First, as the interview was recorded in stereo, the interviewer's track was deleted. Second, the Audacity *Truncate Silence* effect was used to truncate any silence in the participant's channel that was longer than one-half second to a truncated length of one-tenth of a second. Finally, the Audacity *Change Tempo* effect was used to increase the audio to 140% of the default tempo. While increasing the speed of audio normally results in a higher pitch, the *Change Tempo* effect attempts to keep the same pitch so that any distortion in the audio is almost imperceptible. The resultant audio was approximately half as long as the original interviews.

The interviews were then coded using the *Transcript Code Book* (Appendix G) developed for this study. As a verification on the coding process and the clarity of the code book, the researcher selected one interview for coding by a second researcher, who was not involved in this study. After discussing each item in the code book and potential interpretation, the second researcher coded the transcript. An inter-rater reliability for each item was calculated. Overall agreement had a mean of 97.7%, a median of 98.6%, and a standard deviation of 2.8%.

Pearson product moment correlation. Strictly speaking, Likert data is nominal. However, because it is ranked, it can be treated as ordinal. Furthermore, the data can be treated as interval data for the purpose of creating correlations. As Norman (2010) noted with regard to the Pearson product moment correlation, "The Pearson correlation like all parametric tests we have examined, is extremely robust with respect to violations of assumptions" (p. 630). Such is the data in the survey and the Pearson

product moment correlation is an appropriate measure. Here, the Pearson product moment correlation will be referred to as Pearson *r*.

Where ever analysis using correlation is reported in the following analyses, pairs of the summative factors discussed above, with each factor constructed from multiple response items on the survey, were correlated using Pearson *r*. Results are only reported for a two-tailed probability significance, *p*, less than 0.05, which corresponds to an *r* of approximately 0.16 and higher for the number of survey participants (N ≥ 106) for each measure. A probability significance less than 0.0005 is reported as 0.000.

The Pearson correlation strength descriptions for each pair follows the suggestions of Dancey and Reidy (2011) where absolute values between 0.1 and 0.3 are weak, 0.4 to 0.6 are moderate, 0.7 to 0.9 are strong, and above 0.95 is perfect. Borderline values, e.g., 0.34, may be described as straddling both categories, e.g., weak to moderate.

Item identifiers. In some cases, the unique identifies used for each item, whether an individual question on the survey or a summative factor, may be shown in parenthesis, e.g., *(SUA)*. This allows for easier comparison to the data in Appendices A, B, and F. The individual items composing each summative factor can be found by using the name given here, located that in the short reference column of the summative factors in Appendix F.

Survey completion. Participants could begin, pause and resume the survey later by entering in their email address, but about half of the surveys that were started were never completed. Since email addresses were not associated with the survey, the survey system design did not allow reminders to be sent to participants who had partially completed a survey. Without a reminder, participants who started a survey may not have remembered to return to complete it. Only completed surveys were used in the analysis.

Final participants. The research participants were self-selected as participants were primarily recruited through announcements. Of the 307 attempts for the online survey, 89 did not meet the criteria for inclusion in the research, and the fall-off rate (surveys completed compared to surveys started) was 50%, with 218 surveys started and only 108 of those completed. With the number of valid respondents being close to 100, the values for percentages are reported as whole numbers. As none of the questions in the survey were required before the participant could move to the next screen, a participant would occasionally skip a question, resulting in some questions having fewer than 108 responses. The number of responses is shown in the following tables as *n*.

Survey Participant Demographics

Demographics in this research are the general characteristics of the schools or participants when the survey was completed, and allow for comparison, such whether public schools or independent schools have different characteristic that affect the BYOD program. School type (Table 4), is a category that describes the funding of the school: *public school* (government funded), *secular independent school* (primarily funded through tuition), *religious independent school* (primarily funded through tuition but also affiliated with a religious organization), or some other type. Participants were not asked to indicate what the *Other* category included, although it did not include charter schools as that was one of the selections and no participants selected the charter option. Slightly more than two-fifths of the participants reported that they taught in public schools, about half taught in either secular or religious independent schools, and the remainder reported their school type as *Other*. However, the schools in category *Other* were not in North America and many international school teachers may not realize that schools formed to serve the international community are considered independent schools as they charge tuition even if they are non-profit. As such, the category *Other* was considered to be an independent school for the remainder of the analysis.

Table 4

Participant School Demographics: School Type

Public	Secular Independent	Religious Independent	Other
43%	33%	16%	8%

Note. Other is treated as a secular independent school for the purposes of further analysis. *N* = 106.

School setting (Table 5) describes the density of the population of the surrounding area. Most of the schools were in populous areas, with about one-third in urban settings and another half in suburban settings. The rest were either town or rural, while none were reported as remote. Although the United State Census Bureau has definitions for each of these types of settings, the definitions were not given on the survey as the definitions might not have been applicable in other countries. Therefore, the responses depended on the participant's understanding of each of those terms.

Table 5

Participant School Demographics: School Setting

Urban	Suburban	Town	Rural
34%	48%	11%	8%

Note: N = 108.

The participants were located both within and beyond North America (Table 6). About three-fifths of the schools were in North America and the remaining two-fifths outside of North America. Based on how the requests for participants was distributed, a good working assumption is that the non-North American schools are national schools in Anglophone countries, or are International schools teaching primarily in English.

Table 6

Participant School Demographics: School Location

North America	International
61%	39%

Note: N = 106.

Participants' years of teaching experience and years using digital technologies professionally (Table 7) can be indicators of their mastery of teaching and understanding of digital technologies. A bit more than two-thirds of the teachers (71%) had been teaching for more than ten years, and more than half (59%) had been using digital technologies professionally for more than ten years. Overall, the teachers who completed the survey were experienced as teachers and in using digital technologies professionally, with very few neophytes of less than three years' experience. Also, while 57% of the teachers had more than 15 years teaching experience, only 35% had been using digital technologies professionally for that same period. That is, 20% of the teachers who were teaching in 1999-2000 did not use digital technologies in their work during that year. This 20% may indicate a late effective use of digital technology in many schools even though research had been done in the 1970s and 1980s on integrating technology in schools (Kay & Goldberg, 1977; Sandholtz et al., 1997), and most schools had some form of digital technology available by 1999-2000 (Cuban, 2001).

Table 7

Participant Years of Experience

Attribute	0-2	3-5	6-10	11-15	More than 15
Teaching	1%	11%	17%	14%	57%
Using digital technologies professionally	4%	11%	26%	24%	35%

Note: N = 108.

The majority of teachers taught high school, with about one-third (34%) reporting that they taught middle school at the time of the survey (Table 8). Very few reported teaching primary school (6%), and most of the participants were in the high school (60%). As more teachers were in high school, the assumption is that at the time of the research more BYOD programs were in high schools. No definitions for the school levels were in the survey, resulting in teachers selecting the level based on their local understanding of how the school levels in the survey linked to their own school levels.

Table 8

Participant Primary Teaching Assignment

Primary	Middle	High	VoTech
6%	34%	59%	1%

Note: N = 108.

Participants who reached the end of the survey were offered the opportunity to designate a charity, either Save the Children, Books for Africa, or both, to receive a small contribution of three dollars U.S. as an expression of gratitude for their completion of the survey (Table 8). About half opted for both charities to receive part of the donation, about one third opted for Save the Children, and the remainder selected Books for Africa. The incentive allowed the participant, at the completion of the survey or interview, to designate a small sum to be donated to one or both of two charities, Save the Children and Books for Africa. The incentive for completing the survey was three dollars, and the incentive for completing the interview was ten dollars. The total raised for charity was $234.00 for Save the Children and $216.00 for Books for Africa.

Table 9

Participant Desired Charity Contributions

Save the Children	Books for Africa	Both
31%	17%	52%

Note: N = 102.

Interview Participant Demographics

Interview participants were varied in their school setting, school type, school level, and BYOD Model (Table 9). The BYOD models were varied, with the common ones being Bring Your Own Anything (BYOA), where any device could be used, and Bring Your Own Laptop (BYOL), where students had to bring a laptop. For the BYOL programs, the schools set minimum specifications for file interchangeability, but the choice of type and operating system was up to the students and parents. However, even in the BYOL schools, students were usually allowed to use their other devices (tablet or

phone) for learning if they had one. One school required students to bring in a Chromebook® or tablet as a minimum. The 12 interview teachers overall were quite experienced in both teaching (median of 17 years) and using digital technologies in the classroom (median of 10 years).

Table 10

Interview Participant Demographics

Teacher	Location	Setting	School Type	Level	Years Digital Technology	Years BYOD	Years Teaching	BYOD Model
1F	NA	T	P	HS	9	2	7	BYOA
3B	NNA	S	P	HS	16	4	20	BYOA
4D	NA	U	I	ES	15	2	15	BYOL
4F	NA	U	I	MS	6	2	22	BYOA
6E	NA	S	P	MS	10	1	14	BYOA
7A	NNA	U	I	MS	20	3	30	BYOL
9A	NA	S	P	HS	5	3	5	BYOA
A5	NNA	U	I	HS	5	4	18	BYOA[a]
C1	NA	S	P	MS	10	2	26	BYOA[b]
D9[c]	NNA	U	I	All	-	-	-	-
DD	NNA	U	I	MS	17	3	17	BYOA[d]
DE	NA	T	P	MS	8	2	8	BYOL
				Median	10	2	17	
				Mean	11	2.5	16.5	

Note. Location is North America (NA) or Non-North America (NNA). Setting is suburban (S), town (T), or urban (U). School Type is public (P) or Independent (I). School Level for the teacher is High School (HS), Middle School (MS), or Elementary School (ES). [a]Supplemental to school-issued laptops. [b]Students were required to bring a Chromebook® or a tablet at a minimum. [c]Teacher D9 was a technology coordinator providing information about various BYOD trials; the results are not included in the coded analysis. [d]Supplemental to school-issued tablets.

BYOD Programs

One goal of the research was to understand how long teachers had been involved in programs where students were encouraged to use their own digital devices in their classrooms. Teachers varied in the length of time that they were involved in a BYOD program, whether as part of a school BYOD program or as an informal teacher decision to allow students to use their own devices (Table 11). The mode for BYOD was two years of experience, with one-quarter of the participants having worked with BYOD for four or more years. As three-quarters of the participants had two or more years' experience

with BYOD, just as with teacher experience with digital technology (Table 7), few of the participants were neophytes with BYOD.

Participants who reported they started BYOD in the year the survey was taken are listed as current year.

Table 11

Years BYOD in School

Current year	1 year	2 years	3 years	4 or more years
10%	15%	34%	16%	25%

Note: N = 108. Participants who reported they started BYOD in the year they took the survey are listed as current year.

Almost all schools (92%) had a written policy for their BYOD program, with only eight survey respondents reporting that they did not have a written policy (Table 12). Almost all schools also made the policy accessible to parents and students through the Internet. The number of participants (*N*) for each question differ, potentially because some of those who did not have a written policy also selected that they did not post the (non-existent) policy on the Internet, whereas others who did not have a policy skipped the question.

Table 12

BYOD Policy Accessibility

Policy Location	Yes	No	*n*
Written	92%	8%	107
On the Internet	90%	10%	103

Findings: Teacher Technology Use, Student Access, and Student Device Learning

The demographic data given in the previous section relayed characteristics of the teachers, the schools, and the BYOD programs. The findings, reporting how teachers perceive their BYOD programs, follow and are organized using the dimensions of the conceptual framework developed earlier. That is,

the findings are grouped in teacher technology use, student access to devices, or student device learning.

Dimension 1: Teacher technology use. Teachers with constructivist-compatible beliefs or actions have been found to be more likely to be effective digital technology users (Tondeur et al., 2008) and use it in more innovative ways (Becker & Riel, 2000). The analysis begins with an attempt to replicate these results that found a correlation between constructivist beliefs and different dimensions of technology use in BYOD classrooms. As such, for analysis, measures resulting from subsets of the Constructivist Learning Environment Survey, CLES 2(20; Johnson & McClure, 2004), which indicate constructivist-compatible beliefs, were each correlated with the combined results of response items that assessed teacher knowledge or actions. In this case, the teacher beliefs were the independent variables, and the knowledge or action were the dependent variables.

The subset of questions from the CLES 2(20) came from questions on the personal relevance, uncertainty, shared control, and student negotiation sections. Personal relevance refers to the teacher's belief that the lessons inside a classroom should have some connection to a student's life outside of school. Uncertainty refers to the teacher's belief that students should have opportunities to work on problems that do not have well-defined parameters or single answers, just as in the real world. Shared control refers to students participating in decisions about how their learning will happen, and student negotiation refers to students explaining and justifying their ideas and problem solving approaches with other students (Johnson & McClure, 2004). Personal relevance and uncertainty were assessed together using six items, and shared control and negotiation were assessed together with six items. Personal relevance and uncertainty will be referred to in the discussion as *Real World Connections* (factor SUC) and shared control and negotiation will be referred to as *Student Communal Involvement* (factor SUD). As both variables were constructed from items that each applied to two separate categories in the CLES 2(20) a check on internal consistency was run. Cronbach's alpha (α) for the five items in Real World

Connections is 0.87, and for the seven items in Student Communal Involvement is 0.78. Both values indicate a high degree of internal consistency.

These two variables, Real World Connections and Student Communal Participation were then correlated with six variables linked to teacher practices with technology:

- Teacher Technology Use (six survey items, $\alpha = 0.87$, TKA);
- Teacher Specific Technological Pedagogical Knowledge (TPK) (six survey items, $\alpha = 0.88$, TKB);
- Teacher General TPK (four survey items, $\alpha = 0.84$, TKC);
- Teacher Technology Use Frequency (ten survey items, $\alpha = 0.83$, TKE);
- Student Solo Technology Use (ten survey items, $\alpha = 0.83$, SUA), and
- Student Collaborative Technology Use (nine survey items, $\alpha = 0.82$, SUB).

TPK follows the characterization of Mishra and Koehler (2006) where it refers to a teacher's knowledge of how to use technology for teaching. *Teacher Specific TPK* refers to knowledge of helping students do specific learning or productivity tasks on the Internet. *Teacher General TPK* refers to a teacher's overall knowledge of using technology for teaching. *Student Solo Technology Use* is any use where students work by themselves or just with the teacher, for example researching on the Internet without a partner or group, or writing an assignment that will only be read by the teacher. *Student Collaborative Technology Use* refers to any use where students work with others, communicate with others using the technology, or share their work with others. Examples of collaborative technology use are peer editing, creating a presentation to share with the class or on the Internet, or connecting with professionals or subject matter experts from other locales.

The largest correlation with teachers' overall self-reported constructivist beliefs was the moderate positive correlation with the frequency with which teachers use various technologies (Table 13), followed by a weak to moderate positive correlation with Student Solo Technology Use.

Table 13

Correlations Between Teacher Beliefs and Teacher Practices

	Real World Connections		Student Communal Involvement	
Variable	*r*	Strength	*r*	Strength
Teacher Technology Use Frequency	0.50	Moderate positive	0.38	Moderate positive
Student Solo Technology Use	0.42	Moderate positive	0.27	Weak positive
Teacher Specific TPK	0.34	Weak to moderate positive		
Teacher Technology Use	0.34	Weak to moderate positive		
Student Collaborative Technology Use	0.29	Weak positive	0.37	Moderate positive
Teacher General TPK	0.29	Weak positive	0.27	Weak positive

Note: Only includes correlations for which the Pearson *r* is equal to or greater than 0.20. For all *r* values, $p < 0.001$, $N = 108$.

School support for technology may affect how a teacher uses technology. For example, if a school has limited technology resources, or if the administration in a school discourages the use of technology, teachers are less likely to embed technology in their practice. Here, the factors external to the teacher were correlated with the teacher practice factors under more control by the teacher to determine if a relationship existed. The measures used to assess school support of technology, that is, factors external to the teacher, were:

- Administrator Technology Support (five items, $\alpha = 0.70$, TKD);
- Professional Development Support (six items, $\alpha = 0.90$, SFK);
- Teacher Time Availability (three items, $\alpha = 0.78$, SFQ); and
- Overall Atmosphere (six items; $\alpha = 0.73$, SFN).

Overall Atmosphere refers to subject culture, knowledge and skills of students or other teachers, and the action or influence of parents, community or administrators. If the Overall Atmosphere hinders

a teacher in using digital technologies rather than supports a teacher, it is a first order barrier (Ertmer et al., 2012).

These school support of technology measures were each correlated with teacher practice measures reported in the previous comparison, that is, factors under more control by the teacher:

- Teacher Technology Use (TKA);
- Teacher Specific TPK (TKB);
- Teacher General TPK (TKC), and
- Teacher Technology Use Frequency (TKE).

Out of sixteen pairs of measures tested for correlation, six had positive correlations (Table 14). Of these, technology use frequency was positively correlated will all four of the school support for technology measures, with Overall Atmosphere and Teacher Time Availability having the greatest correlation. Conversely, the correlation between administrator support and Teacher Technology Use was present and positive, but it barely met the threshold for inclusion.

Table 14

Teacher Practices Correlated With School Support for Technology

Variable		Teacher Technology Use Frequency	Teacher General TPK
Teacher Time Availability	*r*	0.44†	0.29†
	Strength	Moderate positive	Weak positive
Overall Atmosphere	*r*	0.41	0.27
	Strength	Moderate positive	Weak positive
Professional Development Support	*r*	0.24*	
	Strength	Weak positive	
Administrator Support	*r*	0.20*†	
	Strength	Weak positive	

Note. Unless otherwise indicated, $p \leq 0.01$, $N = 108$.
*$p \leq 0.05$. †$N = 106$.

BYOD perception and attitude. Just as school support for technology may affect teacher practice, the way in which a school implements their BYOD program may also affect teacher practice. To explore this relationship three factors from the survey were chosen as independent variables:

- Technology Availability, (SFJ; eight items; $\alpha = 0.70$)
- Specific External Factors (SFM; eight items; $\alpha = 0.88$) and
- Overall Atmosphere (the same overall school and community atmosphere factor used above).

These are independent variables in the sense that they are external to, and independent of, the teacher, but can possibly influence teacher actions. *Technology Availability* primarily refers to the availability of end user equipment such as computers, laptops, tablets, display, technology, technology support and availability of an Internet connection. *Specific External Factors* are those factors external to the teacher and out of the teacher's control, and teachers assessed the extent to which these factors helped or hindered their use of technology. Examples of items that make up Specific External Factors for this research were technology reliability, effective wireless access, overall funding, and state standards or standardized assessments. When external factors hinder a teacher in using technology, they become first order barriers (Ertmer et al., 2012).

These variables were then correlated with factors internal to the teacher, that is, teacher evaluation of BYOD (*Teacher BYOD Evaluation*) and teacher attitude towards BYOD (*Teacher BYOD Attitude*), to determine if the external factors correlated with evaluations and attitudes. The Teacher BYOD Evaluation measure, an indication of how teachers perceive BYOD, was developed from two responses on the survey that asked teachers to indicate their level of agreement with the statement that "BYOD is exciting," and then to indicate their level of agreement with the statement that "BYOD is more trouble than it is worth." The questions are modifications of questions from the Teacher Attitude Towards Technology Survey (Shattuck et al., 2011) and were measured on five point Likert scale from 1

(*strongly disagree*) to 5 (*strongly agree*). The results were then displayed on a scale from 1 (*least favorable*) to 5 (*most favorable*). To create the Teacher BYOD Evaluation measure, the scale regarding BYOD being more trouble than it was worth was reversed prior to creating the measure. The data from the measure Teacher BYOD Evaluation indicates a right skew, meaning that the participants' evaluation of BYOD was positive overall (Figure 10).

The Teacher BYOD Attitude measure was created from a series of four semantic differential questions adapted from the Teacher Attitude Towards Technology Survey. A semantic differential question asks participants to indicate how they feel by selecting a position between an adjective pair. For example, one item was, "BYOD is Dull•••••••Exciting", with seven positions between dull and exciting. The adjectives with very negative connotations (*Suffocating, Dull, Unlikeable, Unhappy*) were given a value of 1, while the adjectives with very positive connotations (*Fresh, Exciting, Likeable, Happy*) were given a value of 7. The adjective pairs were randomly presented with either the positive connotation or the negative connotation first (Appendix A). Teacher BYOD Attitude skewed to the right, indicating teachers had an overall positive attitude toward BYOD (Figure 11).

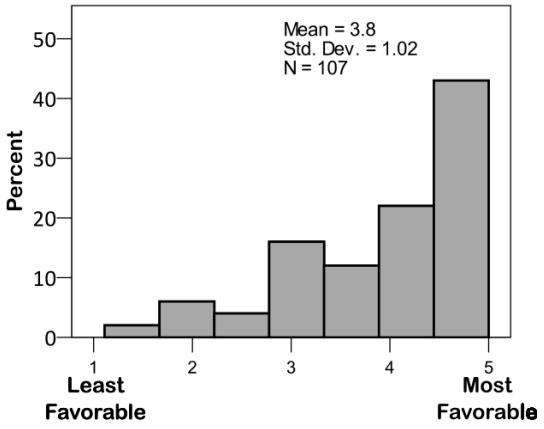

Figure 10. Teacher BYOD Evaluation on a five-point scale ranked from *Least Favorable* to *Most Favorable*.

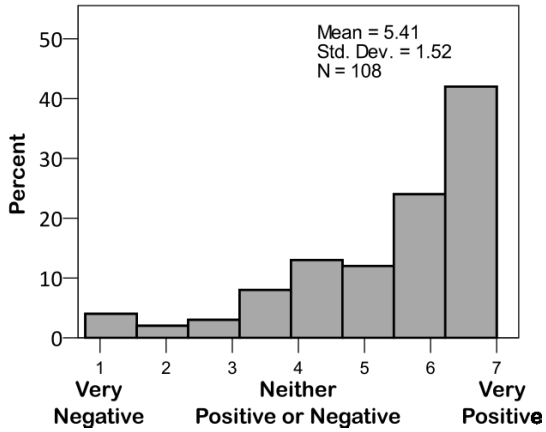

Figure 11. Teacher BYOD Attitude, derived from semantic differential questions, on a seven-point scale ranked from *Very Negative* to *Very Positive.*

The greatest effect was that the Overall Atmosphere had a moderate positive correlation with Teacher BYOD Evaluation and Teacher BYOD Attitude. Specific External Factors were weakly to

moderately positively correlated with Teacher BYOD Evaluation and Teacher BYOD Attitude, and Technology Availability only had a weak positive correlation with Teacher BYOD Evaluation and Teacher BYOD Attitude (Table 15).

In addition to the correlations above, teachers were asked to what extent their frequency of use of technology in the classroom had changed in recent years. Recent years was not defined so each teacher determined the period when that occurred. On a five point Likert scale from Decreased significantly (1) to increased significantly (5), the mean value was 4.5 with a median of 5 and a standard deviation of 0.76 with *N* = 108. Eight teachers reported that their use of technology had not changed, and only three teachers reported that their use of technology had decreased.

Table 15

Teacher BYOD Evaluation and Attitudes Correlated With General External Factors

	Overall Atmosphere		Specific External Factors		Technology Availability	
Variable	*r*	Strength	*r*	Strength	*r*	Strength
Teacher BYOD Attitude	0.41[a]	Moderate positive	0.36	Moderate positive	0.26[a]	Weak positive
Teacher BYOD Evaluation	0.36	Moderate positive	0.33[b]	Weak to moderate positive	0.21[c]	Weak positive

Note. $p \leq 0.01$ and N = 107 unless otherwise indicated.
[a]*N* = 108. [b]*N* = 106. [c]$p \leq 0.05$.

Teachers were also asked as part of the survey to write in an open response item what they would tell parents about their BYOD program. Of 108 participants, 86 participants provided information, with 85 participants providing enough information to that allowed a determination how each participant viewed the effectiveness of the program. The open response items were then coded based on whether the comments indicated that the program was ineffective, somewhat ineffective, somewhat effective, or effective (Table 16). This data on program effectiveness is also right skewed, which matches the data trends for Teacher BYOD Evaluation and Teacher BYOD Attitude.

Table 16

BYOD Effectiveness from Coding Open Response Items

Ineffective	Somewhat Ineffective	Somewhat Effective	Effective	*N*
12%	5%	33%	50%	85

As a way to assess perceptions of the interviewees about BYOD, teachers were asked to tell of times they thought BYOD was successful and when it was not successful. Perceptions about BYOD came from most of these. Of the eleven completed interviews, ten teachers viewed BYOD as either effective or very effective in their classrooms, describing their BYOD program in terms such as, “Now that we have Bring Your Own Device, my life has become a lot easier (Teacher 7A),” or “I love it. I absolutely love it. It has reinvented me as a teacher (Teacher 4F),” or “It doesn’t feel special. It just feels normal (Teacher 3B).” Those positive views do not mean that BYOD was without challenges. Teacher 9A, in discussing a lesson that “fell apart” revealed a theme of internal tension, “it takes someone very risky to give up that control and say, ‘This may work and it may not, and we’ll go with it.’” Other teachers also referenced this internal tension, with Teacher 4F stating the tension as “a mindset challenge of letting go of the reins of the classroom,” while Teacher 4D used a metaphor, “It definitely feels a little bit like jumping without a parachute even though I know everything is going fine.”

Administrator support. From the survey, correlation between administrator support and Teacher BYOD Evaluation or Teacher BYOD Attitude is essentially non-existent, yet there still may be an effect that did not become apparent in the survey. Teachers who were interviewed had divergent perceptions of the support they received from their administrators and from their institution. Of the interview participants who mentioned their administrators, five had a positive view of their administrators, while four had negative views. One teacher, who felt well-supported, reported of her administrators, "I know I probably sound like the crazy teacher but they're very open, they want that innovative teacher in there because it makes the kids take ownership of their learning (Teacher 9A).”

And that type of support shows up in various ways. Teacher A5 reported an administrator dropping in to class to suggest ways to approach BYOD, and Teacher 9A, quoted above, reported an administrator coming in to class to assist with introducing a new topic to the students.

In contrast, four teachers reported on the confusion other teachers felt with BYOD and the seeming lack of planning by the administration. One of these teacher felt that the school administrators habitually did not provide much support for integrating digital technologies. She told of an incident that happened shortly after she joined the district where teachers were asked to evaluate new digital technology devices for use in their classrooms:

> A woman [in the meeting] broke down and started crying. [When I talked to her about it] she's just like 'I'm just so sick of the same old same old. You know, we're here, we're looking at this product, we're devoting our time to answering questions about what we want in the classroom, and we're gonna go back [to the school] and nothing's going to change.' (Teacher 1F).

Teacher 1F used that story to illustrate that the lack of support from the school and district administrators was not due to BYOD, but had been the situation in the school for a while. Another of the teachers told of well-meaning but less knowledgeable administrators:

> It's all just like they encourage BYOD but they don't know anything. It's just like you're kind of on your own. […] You can talk to the IT Director, and she basically will work with you to try and resolve any issues if it's kind of ongoing but it's pretty much fend for yourself (Teacher 6E).

In both cases, administrators were encouraging BYOD, but were not following through with actions that teachers would view as supporting the professional and institutional needs of the teachers in the BYOD program.

Constructivist principles. As introduced above, for constructivist principles measured in Real World Connections and Student Communal Involvement, the participant mean and median response for the frequency of which they engaged in both activities was a bit more frequently than *often*, indicating that most teachers regularly engaged in teaching that was consistent with constructivist principles (Table 13). This engagement in constructivist principles surfaced in the interviews, where all of the interview participants mentioned teaching or procedures that were consistent with such principles.

These included Student Communal Involvement actions, such as “opening up that audience for those students and making it more authentic, making it more challenging (Teacher DE),” or “build enough space and time into the lessons for them to ask each other for help (Teacher A5).” Teachers also mentioned engaging students in activities assessed in Real World Connections, with an emphasis on communicating outside the classroom in various ways. Four of the participants mentioned learning together with their students, such as, “The students and I have been learning together about [movie making] (Teacher 1F),” “I learn stuff from my students every single day (Teacher C1),” or “Nobody knew, including myself, how to use the [green screen] technology and the kids said, ‘Oh well, we’ll figure it out.’ (Teacher 4F)”

Dimension 2: Equity and access. Participants were directly asked on the survey to indicate their level of agreement with statements about whether BYOD programs could be implemented in such a way as to address equity among students, and whether the BYOD program *at their school* had been implemented in such a way as to address equity among students. Both questions were assessed on a five point Likert scale that ranged from strongly disagree (1 point) to strongly agree (5 points) where the teachers were asked to agree or disagree with a statement. The information from the Likert scale was treated as interval data for the purposes of evaluation.

The prompt for the first statement was, “BYOD programs can be implemented in such a way as to address equity among students.” This was the ideal case, where teachers expressed their belief about whether a BYOD program could be implemented to address equity. The prompt for the second case was, “At our school, BYOD has been implemented in such a way as to address equity among students.” This was the actual case, where teachers expressed their belief about whether the BYOD program as implemented in their schools actually addressed equity among students. The question relied on the teachers having an internal belief about equity as equity was not defined in the survey.

The data suggest two findings (Table 17). The first is that teachers either agree (48%) or strongly agree (15%) that BYOD programs can be implemented so as to address equity among students. Looking at the inverse, only 12% of the teachers surveyed believed that BYOD programs could *not* be implemented equitably. However, in spite of this widespread belief that BYOD could be implemented equitably, the second result is that fewer teachers agreed (34%) or strongly agreed (12%) that the program at their school had been implemented so as to be equitable. Overall 25% of the teachers believed that their BYOD program was *not* equitable.

Table 17

Equity Belief and Practice

Item	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean	Median	*SD*
BYOD programs *can be* equitable[a]	2%	10%	26%	48%	15%	3.7	4.0	0.9
My school BYOD program *is* equitable[b]	5%	20%	29%	34%	12%	3.3	3.0	1.1

Note. N = 105, *SD* = Standard Deviation. Attributes were assessed on a scale of 1 (*Strongly Disagree*), 2 (*Disagree*), 3 (*Neither Agree nor Disagree*), 4 (*Agree*), and 5 (*Strongly Agree*).
[a]Survey item by_h1. [b]Survey item by_h2.

This disparity between what teachers thought could be accomplished compared to what was being accomplished in their schools is seen in the measures of central tendency and dispersion, where the mean (3.7 compared to 3.3) and median (4.0 compared to 3.0) were higher for the idealized case (equity is possible) and the actual case (equity is not happening in my school). Furthermore, fewer than half of the teachers surveyed agreed with the statement that the BYOD program in their school had been implemented to address equity, whereas 63%, or almost two thirds, responded that equity was possible in a BYOD program. Approximately the same number of participants selected the neutral option of neither agreeing nor disagreeing about the possibility of idealized equity and actual equity (26% versus 29%). That result may indicate that teachers had not thought of equity, that teachers were

ambivalent about equity issues within a BYOD program, or that teachers did not wish to commit to an answer. If the participants had not had the neutral option for idealized equity and actual equity, the ratio of those who agree to those who disagree might change.

Looking at the converse, that is, reporting the responses of those who disagreed that equity was possible, only one out of eight (12%) responded that BYOD programs could not be equitable, while one out of four (25%) responded that their own program was not equitable.

School approach to equity. As a check on the equity responses, an open response question was included in the survey asking participants to provide information about whether student equity was addressed in their BYOD program and how it was addressed. Of 108 participants, 80 chose to provide a response. An analysis of the number of characters in each response of the equity open response item provides information about how detailed the responses were (Table 18). The median length was 127 characters, with a standard deviation of 168 characters, indicating that overall the participants who chose to comment did provide sufficient detail for analysis, with some providing deeper explanations of their position.

Table 18

Analysis of Number of Characters in the Open Response Question on Equity

Mean	Median	Minimum	Maximum	*SD*	*N*
167	127	12	1276	168	80

Note. SD = Standard Deviation

All of the responses were read to determine which themes emerged about how schools addressed equity, then codes assigned to the themes (Table 19). As equity was not defined in the survey, participants answered with their own interpretations of equity, resulting in 74 responses that did provide information about equity in their school and six that did not contain enough information to determine how equity was addressed.

Table 19

School Approach to Equity From Survey Open Response Questions

Theme	*n**	Group†
The school population is affluent, so equity is not an issue.	I = 13	F
The school provides funds or other types of monetary support for the parents to acquire a device.	I = 3	F
The school assigns a dedicated device to the student.	P = 11, I = 9	S
The school has devices in the classroom that students can use, or that they can check out for use during a school day.	P = 5, I = 2	L
The student partners with one or more other students.	P = 3	NA
The school checks out an inadequate device (iPod or a slow, out-of-date school laptop) to the student during the day.	P = 3	NA
The school does not formally address equity, although teachers may address it through grants for devices or may have devices in the classroom.	P = 15, I = 10	NA

Note. Total *N* = 80, with six responses that did not contain enough information to determine how equity was addressed. Of the remaining, 37 responses were from public schools and 37 responses were from independent schools.
*P = Public school, I = Independent school. †F = Funded Access group, S = Supported Access group, L = Limited Access group, NA = No Access group.

The themes were further grouped by how schools approached the issue of assuring that every student had access to a device. The *Funded Access* group was the group for which the school population was either affluent enough for everyone to afford a device, without defining whether the device is a smart phone, tablet, or laptop, or where the school provided financial support for families to purchase a device if necessary. The *Supported Access* group was the group for which the school provided a dedicated device to the student if the family was unable to afford one. The *Limited Access* group was the group for which classrooms had devices the students could use if they did not bring one, or where students could check out a device for the class or for the day. The *No Access* group was the group for which the school did not have a specific plan in place to address equity, did not provide a device or provided an inadequate device. While one third of the respondents indicated that their school did not have a plan in place to address equity, that would not necessarily mean that the BYOD program was

inequitable as individual teachers often had plans to address equity. Seventy-four of the 80 responses had enough details to be able to assign them a group (Table 20).

Table 20

Equity Open Responses Grouped by School Approach to Providing Device Access

Item	Funded		Supported		Limited		No Access	
	P	I	P	I	P	I	P	I
Number of responses	0	16	11	9	5	2	21	10
Percentage	0%	43%	30%	24%	13%	6%	57%	27%
Overall Percentage	22%		27%		9%		42%	

Note. N = 74 total responses, with 37 responses from public (P) schools and 37 responses from independent (I) schools.

Teachers who were reporting on the access to devices in public schools reported that either the school provided personal devices for students to borrow for the year (30%) or the teacher provided a device for use in the classroom (9%). However, in most of the schools (57%) if the students did not have a device they had to work with someone who did have a device or the student did not have access. It is possible that these public schools treated BYOD as optional and therefore did not feel the need to provide devices to students who did not have their own.

The data for independent schools is slightly different. In nearly half of these schools (42%), access to devices was not an issue. In these schools, students brought their devices from home and if there was a student who could not afford to do so, partial or full funding was provided by the school depending on student need. Another quarter of the teachers (24%) reported that the school loaned the student a personal device for use during the semester or year. Only two teachers reported loaning student devices at the classroom level. While it was a lower percent than in public schools (27% compared to 57%), in slightly more than a quarter of the classrooms (27%) teachers reported that students who did not have devices would have to do without or partner with someone with a device. When it came to assuring that a student had a device, 43% of independent schools were more likely to have an affluent enough student body where equity was not an issue or subsidy could help parents

purchase an appropriate device. The percentage of independent schools that assigned a dedicated device (23%) was roughly equal to the percentage that treated BYOD as optional and did not provide a device (27%).

Equity and access. Equity and access were also addressed by interview participants. When discussing equity practice in their schools, six teachers said that their BYOD program was equitable, and five reported that their program was mostly equitable but that it might not be equitable under slightly changed circumstances. Of those who expressed concerns about the circumstances of the equity in their programs, one teacher reported that the devices for loan in the classrooms would be used for school testing in a few weeks, making them inaccessible to students. Yet the teacher also reported on a family with eight children who were provided a device by the PTA for the children to share among themselves. In that case, the children each took the device on one day, then used classroom devices on the days another child was using the family device. Another teacher was concerned as she only had devices for loan in her room because she had received a grant, but other teachers in the school did not have anything to loan. Teachers are concerned by equity and take steps within their power to make BYOD more equitable.

Of those who reported that BYOD was equitable, five had responses that indicated their school was in the funded, supported, or limited category, while one reported the program as equitable even though it was in the no support category. That last teacher, in a suburban setting, felt that smart phones provided the equity, “In my experience, the equity, its smart phones—all of them. Even the kids who, you know, maybe [low income] or no Internet access at home or computer access at home, but have a smart phone (Teacher 9A).” The same teacher contrasted school-issued laptop one-to-one programs with BYOD programs where students had a variety of devices in the classroom, “I don't think [all students having the same laptop] is necessary. I don't even think that would be beneficial. I think that would be a little overboard.”

Teachers also discussed the ways in which students had access when they were unable to use their own device. Nine reported that students used school-owned devices, seven reported that students partnered with other students, two reported that students used secondary devices they had with them (e.g., a smartphone if the student forgot the laptop at home), and two reported that there were times when students had no access. The total of reported actions is more than the number of teachers as six of the teachers had different ways of helping students have access, with *no access* being the least favorable, and some finding partnering to be only marginally acceptable depending on the situation. As Teacher 1F phrased the sharing circumstance, “It was really a last resort because resources were so poor.” Yet Teacher 9A framed sharing differently, “I don’t see anything wrong with partnering up,” when indicating that there are circumstances where students “have a phone but they don’t have Internet access because their parents grounded them or something.” The variety of responses from teachers would seem to indicate that teachers have considered various ways to address access, even when the school is a no support school.

Teachers were also concerned by equity that might be due to different capabilities of devices that students can afford to bring to school. Teacher DD, in an independent school where students were required to bring laptops, was concerned by “the quality or the newness of the device that would have been provided [by the parents]” and reported that parents of students who were not as wealthy would give the student “the five-year-old laptop that weighed fourteen pounds.” Another teacher felt more strongly, “I think all the kids should have the same, quality access. I just feel like it's unfair for those who can't afford quality devices in a BYOD system (Teacher 1F).” While a disparity in device capability was a concern for teachers, it was not necessarily a concern for students:

> I think that's something in the heads of parents and in the heads of teachers sometimes, but in reality, you put four students around a table and give them a collaborative task, they'll all bring their devices out and they'll decide for themselves. Someone happens to have a mini-tablet, then that might be the one you choose to create the presentation on, because it's got a bigger screen. If someone's phone will record video in HD, then we'll use that for recording the video.

> They all decide that as a group and nobody will take offense if their device isn't chosen for a particular purpose. They'll look at the tools available and make the best selection (Teacher 3B).

While the students' perceptions of equity were not part of the interview, nobody volunteered during the interviews, even when discussing how students shared devices, that students gave any indication that the devices students brought were a reflection of equity. As the interviews were semi-structured, Teacher 3B's response came as the interviewer followed up on a discussion of how the school provided devices for those who could not provide their own. As teachers freely volunteered what they viewed as working and not working in their BYOD program, had student perception of equity been an issue, it likely would have been more evident during the interviews.

Device capability in equity. The capability of the devices that students brought did come up in the interviews with teachers. Five of the teachers specifically mentioned the contrast between tablets and laptop computers. A concern of several teachers was that the Internet browsers on tablets tended to run into issues with sites that were designed for the power of Internet browsers on laptops. Teachers had to plan ways for tablet students to get around the limitations or have a laptop in the classroom for students to use when they were on sites that required a more powerful laptop. Several teachers also mentioned the app ecosystem that comprise tablets. One referred to the apps as divisive, in that he could not plan on using an app available on only one or two platforms as his student brought in devices from the major platforms produced by (or using operating systems from) Microsoft, Apple, or Google. Another teacher discussed the difficulty of using cloud services with tablets because they tended to require an app that would not be available on all platforms, "whereas if you're talking about cloud services on a laptop, a browser is a browser is a browser for the most part (Teacher 4D)." A third teacher believed laptops to be more powerful and capable of supporting complex activities on the parts of students. An additional theme that arose several times was the difficulty students had with multitasking on tablets, for example watching a video in one window while taking notes in another. It just was not teachers who were interviewed who had this experience. Teacher D9 (interviewed for information) also

reported on a fourth grade teacher doing a BYOD pilot program who really wanted to use iPads®. Ultimately, however, for all of the reasons above, the fourth grade teacher recommended a program where students brought laptops instead of iPads®.

Dimension 3: Student device learning. The extent to which teachers perceived that students are successful in using their own devices for learning in a BYOD classroom was addressed with survey items. The teachers were asked to agree or disagree with two statements about how students learned to use their devices. The statements were, "students can learn from each other how to use their devices effectively," and "students can learn to use their devices effectively through working on assignments." In addition, to assess whether teachers perceived a difference in classroom behavior, a third statement, "students behave more appropriately in class with BYOD than without BYOD," was also on the survey. As a way to check teachers' acceptance of the variety of devices that students bring, teachers were also asked their agreement level with the statement, "I like that my students have different devices." The four prompts (Table 21) were assessed on a five point Likert scale that ranged from 1 (*strongly disagree*) to 5 (*strongly agree*).

For the cases of student learning, teachers overwhelmingly agreed that students can learn from each other how to use their devices from each other (83%) and that they can also learn to use the devices through working on assignments (80%). Furthermore, when examining how strongly teachers felt about this topic, about a quarter (27%) strongly agreed that students could learn to use their devices from each other, while 40% strongly agreed that students could learn to use their devices effectively by working on assignments. Conversely, only about one out of every fifteen (6% - 7%) teachers disagreed that students could learn to use their devices from assignments or from each other. These data suggest that teachers were not troubled by students learning how to use the technology as students could learn to use it themselves or from peers during the course of schoolwork.

Table 21

Student Device Learning and Behavior

Survey Item	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean	Median	*SD*
Students can learn from each other how to use their devices effectively[a]	2%	4%	12%	56%	27%	4.1	4.0	0.9
Students can learn to use their devices effectively through working on assignments[b]	1%	6%	13%	40%	40%	4.0	4.0	0.8
Students behave more appropriately in class with BYOD than without BYOD[c]	8%	15%	52%	10%	15%	3.1	3.0	1.1
I like that my students have different devices[d]	9%	22%	27%	21%	21%	3.2	3.0	1.3

Note. Mean and Median assessed on a scale of 1 (*Strongly Disagree*), 2 (*Disagree*), 3 (*Neither Agree nor Disagree*), 4 (*Agree*), and 5 (*Strongly Agree*). *SD* = Standard Deviation.
[a]Survey item by_b8, *N* = 107. [b]Survey item by_b6, *N* = 108. [c]Survey item by_b5, *N* = 108. [d]Survey item by_b2, *N* = 107.

For student classroom behavior, approximately half (52%) of the respondents did not perceive any differences in appropriate student behavior when the students were using their own devices in the classroom. Of the remaining teachers, one-quarter (25%) agreed that students behaved more appropriately, while approximately the same number (23%) disagreed that students behaved more appropriately. In summary, whether teachers notice a difference in behavior when they implement a BYOD program most likely will depend on factors other than just the presence of the student devices.

Most teachers (70%) reported that they liked that students had different devices (42%) or did not feel strongly enough to either disagree or agree (27%) that they liked that students had different devices. Only 30% reported that they disliked that students had different devices, with only 9% feeling strongly about that issue. This data implies that, overall, students using different devices in the

classroom is not an issue for the majority of teachers, and many actually appreciate that students have access to different devices.

Another way to examine student device learning was to find out what happens when students do not know how to do a task with their own device. The teachers were provided with a survey prompt asking them to indicate how often specific outcomes happened when students had their own devices but did not know how to do a task with it. The item prompted the frequency for each item on a five point Likert scale that was anchored by 1 (*never*) on the low end and 5 (*very often or always*) on the high end (Table 22).

Table 22

Student Actions When the Student Does Not Know How to Do a Task With Their Device

Survey Item	Never	Rarely	Sometimes	Often	Very Often or Always	Mean	Median	*SD*
The student seeks help from others[a]	1%	2%	17%	53%	28%	4.0	4.0	0.8
Other students offer to help [b]†	2%	1%	17%	55%	25%	4.0	4.0	0.8
The teacher helps[c]	0%	3%	28%	48%	21%	3.9	4.0	0.8
The student searches the Internet[d]	2%	17%	41%	29%	12%	3.3	3.0	1.0
The teacher calls for technical support[e]	16%	27%	41%	10%	7%	2.6	3.0	1.1
The student does not learn to do the task[f]†	12%	52%	30%	4%	2%	2.3	2.0	0.8

Note. N = 108 unless otherwise indicated. Mean and median assessed on a scale of 1 (*Never*), 2 (*Rarely*), 3 (*Sometimes*), 4 (*Often*), and 5 (*Very Often or Always*). *SD* = Standard Deviation
[a]Survey item *by_g4*. [b]Survey item *by_g5*. [c]Survey item *by_g3*. [d]Survey item *by_g2*. [e]Survey item *by_g6*. [f]Survey item by_g1.
†n = 107

The two most frequent actions, where the responses are *often* or *very often or always*, also occur with almost the same frequency. These are that "the student independently seeks help from other students" (81%) or "other students offer to help the student" (80%). Trailing these two, but also ranking high, is that "the teacher helps the student," with almost 70% of respondents selecting this as

happening *often*, or *very often or always*. For the other options, ("the student searches the Internet for help," "the teacher asks for technical assistance," or "the student does not learn to do the task") none had a majority of respondents selecting *often* or *very often or always*. The least frequent action, "the student does not learn to do the task," had only 6% of respondents that selected *often* or *very often or always*. These results imply that students most often learn how to use their devices for learning through working with others in the classroom.

Student device learning. How students learn to use their devices for learning and how they react when they do not know how to do a task on their devices are similar. Interview teachers reported that students learned how to use their devices from assignments, they learned from each other, they figured out how to do to do a task themselves, the teacher provided help or, occasionally, a school staff member not in the room provided assistance. If students ran into a problem using their devices, an expectation that was explicitly mentioned by seven of the interview teachers was that students try to resolve issues either by themselves or with other students before asking the teacher. Teacher 4D discussed how *student agency*, that is, students taking initiative and ownership of their own learning, was a deliberate policy in her school:

> Our approach is that they need to show some grit and do some critical thinking when they're presented with an issue. […] We encourage them to sit down and say, 'What's the problem and how can I think about a solution without talking to an adult?' And that's actually worked pretty well. Giving them agency seems to be a pretty effective way of cutting off the 'Well, I can't do my homework because my computer's broken!' (Teacher 4D).

Teacher 4D several times rounded back to the theme of how school culture reinforced student agency, which supported the effectiveness of the school's BYOD program. However, even without an explicit focus on student agency, students can take charge of their own learning. As Teacher A5 observed, "They just tap over and say, 'Hey, man, did you get this?' and then they just explain it quickly, and usually they use the lingo that I don't know."

Five teachers reported that their schools provided at least one required technology course or a technology boot camp for students so that that students had some school-taught skills. A technology boot camp is run before school starts, typically just before students enter the grade with a BYOD program, and includes an in-depth introduction to devices. Although not an explicit school policy, other teachers also encouraged student agency, through classroom policies similar to *ask three then me* (a technique where students are expected to ask three other students before asking the teacher) or building in time for exploration when asking students to do something new with their devices. Teachers did, however, facilitate students learning how to use their devices, with some addressing all students in the room to identify themselves to the class if they are already familiar with a particular device or new program. Teacher A5 gave an example of such a practice as, “So if I'm going to use GoAnimate with the class, I'll do a ‘Hands up, who's actually used it before?’

The occasions when devices seemed balky, either from the students not knowing how to use their own devices or because of other issue, could create stress for teachers. The teacher who reported that the BYOD program was ineffective also felt a social pressure to help students troubleshoot their devices, which was problematic given the time challenges of short periods:

> It's just way too much on the teacher then. I don't have the time to troubleshoot five different devices. […] Students come with so many different devices, and if I have forty-two minutes to teach them whatever, that day or that week, about the electoral college, and I'm spending twenty of those minutes trying to download certain software or apps or whatever, so that they can get to the lesson that I want them to be able to see during class, or that night, or to gather research from that week in class, it's a waste of time, and it's extremely frustrating too, because I'm pretty tech-savvy but at the same time, that's not my job (Teacher 1F).

As she also mentioned during the interview the lack of communication or assistance from the school administration, the social pressure that she felt to engage in troubleshooting was possibly due to her own beliefs about how she could be most effective with her own students. Other teachers, though, deferred troubleshooting to students and expected them to work with each other to solve the problem. Only after students tried to solve the problem would some teachers assist in troubleshooting. The

teachers mostly did not consider themselves to be technologists. Instead, their help consisted of working with students to figure out how to do something, with the teacher learning at the same time. As one said, “I’ll just sit down, we’ll do a quick one-on-one conference, and I’ll learn with them (Teacher A5).” Another noted, “I think that when you've been teaching as long as I've been teaching, you learn that you don't really have to be an expert at anything. You just have to be willing to admit that you don't know everything (Teacher C1).” In both cases, they appeared to be modeling the attitude of how to approach a problem, and that troubleshooting is not necessarily instantaneous. They also chose not to persist in the face of intractable issues. If they could not resolve the problem quickly, it was left to the student and family to resolve as the devices were the students’ personal devices and did not belong to the school.

Findings summary. The preceding discussion addressed factors shaping teacher use of technology, equity and access factors, and student learning factors. Each factor is tied to a research question.

Factors shaping teacher use of technology. The largest correlation with teachers’ overall self-reported constructivist beliefs is the moderate positive correlation with the frequency with which teachers use various technologies.

The stronger a teacher’s constructivist tendencies in the constructivist domains surveyed, the more teachers tend to use technology and the more frequently they use technology for instruction and teaching, and for administrative tasks.

As the overall school and community atmosphere was rated more helpful, or the more time teachers had with students, for BYOD planning, or for BYOD discussions with colleagues, the more frequently and varied were the technologies that teachers used. The availability of professional support for using technologies or integrating technologies into the classroom also had a weak positive correlation to teacher frequency and variety of technology use. Two correlations were weak, but still

met the test of significance. One was that an increase in the helpfulness of school and community atmosphere correlated to increased teacher specific TPK in helping students do specific learning or productivity tasks with the Internet. The other was a weak positive correlation where teachers were more likely to use various technologies, and use them more frequently, as administrator support for using various technologies increased.

The more technology a school had available, the less teachers perceived technology availability, technology reliability, overall funding or other external issue as barriers, and the more positive was their attitude to BYOD and the better perception they had of the program. Almost all teachers also reported a significant increase in the use of technology in the classroom in recent years, which included the time when many started using BYOD. Over 80 % of teachers would report to parents that the BYOD program in their school was somewhat effective or effective.

Equity and access factors. Overall, these results imply that what teachers believed was possible with regards to equity was not necessarily achieved in practice. Public schools were more likely to have situations where equity of access was simply not achieved, although interview participants reported more positive results than the survey. This may be because interview participants generally held more favorable views about BYOD, or it may be due to the structure of the survey where participants did not have to commit to declaring their program as equitable or inequitable, which was an option selected by 29%. In effect, schools consider access to digital technology for learning non-essential when they do not have plans or the ability to provide students with devices when they cannot provide their own. Equity is unlikely to happen without planning and these data suggest that, in some schools, BYOD programs create a context of unequal access to tools of learning. While equity is not the same as effectiveness, the results on equity generally agreed with the first research question where 80% of teachers reported their program as effective. Equity in the types of device students use is a concern to teachers, with several reporting that current tablet devices were too limiting and disadvantaged students compared to those

with laptops. However, device disparity between students did not seem to be a concern to the students according to the teachers interviewed.

Student learning factors. Students can learn to use their devices as learning tools without whole class instruction. When faced with not knowing how to use their device to do a task, students almost always succeeded in learning, whether they searched the Internet, worked with others, or figured it out on their own. Teachers may provide assistance for troubleshooting, but most view their key role as facilitating students working with other students to learn about their own devices and solve problems.

Overall. Overall BYOD programs are widely accepted by teachers, teachers believe such programs can be equitable, and the varied devices students bring do not detract from, and may enhance, the learning environment.

Chapter 5. Implications of This Research

Introduction

Mobile electronic devices, such as smartphones, tablets, and laptops, are becoming ubiquitous in the hands of students. In the U. S., over 80% of grade 9-12 students, 68% of grade 6-8 students, and 46% of grade3-5 student in the U.S report having a mobile phone with Internet. Over half of all students in those grades reported having a laptop computer, a tablet or both (Project Tomorrow, 2015b). Many schools are now allowing students to bring their own devices into school and to use them in class as learning tools, which is frequently referred to as a Bring Your Own Device (BYOD) or Bring Your Own Technology (BYOT) program. However, only limited research exists on BYOD usage in the classroom to guide teachers, schools, and superintendents to make the choices of how schools can help students use these devices for learning.

This research adds to the limited body of knowledge about BYOD in the classroom. For the study, three research questions linked to a conceptual framework created as a result of the literature review guided the development of the instruments used. The research questions addressed teacher use of technology, student access to devices and equity that arose from access or lack of access, and students' ability to learn to use their devices for learning. The data suggest that teachers who are overall supported in their use of technology are more likely to perceive that BYOD can be effective and equitable. Furthermore, the variety of devices that students bring to the classroom is not an impediment to learning, and students can effectively use the devices they bring without the teacher knowing how to use the device. A key finding is that few teachers thought that BYOD was inherently inequitable, and teachers had higher perceptions of BYOD in schools that actively supported the BYOD program and arranged short-term or long-term loan of devices to students who, for whatever reason, were unable to provide their own.

Research Questions

The research questions for this study developed to fit into the conceptual framework were:

1. How is teacher incorporation of student devices in instruction related to their own beliefs and practices around the use of technology professionally and for instruction?
    - How are their practices affected by the school support for technology?
    - How are their practices influenced by the school implementation of a BYOD program?
2. To what extent do teachers perceive that BYOD programs provide equitable access for all students?
3. To what extent do teachers perceive that students are successful in using their own technology for learning in a BYOD classroom?

The research questions mapped onto the conceptual framework (Figure 13).

Research Overview

The design was a triangulation study using both qualitative and quantitative data. The research questions were used to guide the development of two instruments, an anonymous online survey for teachers in BYOD programs, and a confidential interview for teachers who completed the survey and then volunteered to participate in the interview. The online survey was intended to provide primarily quantitative data, although it did provide limited qualitative data from open response prompts. The interview was intended to provide primarily qualitative data for triangulation. The survey prompts were either adapted from existing research or developed for this research (Appendix B). The survey was sectioned into five topics,

- teacher knowledge and use of digital technology,
- student use of digital technology,
- bring your own device program specifics,
- factors supporting technology use, and

- demographics.

The interview used eight interview prompts, but was semi-structured so that additional questions could be asked for clarification (Appendix C). A total of 108 participants completed the survey, and eleven participated in the interviews.

Conceptual Framework

As part of developing this research, a conceptual framework was created to guide the research design. That conceptual framework posits that the effectiveness of BYOD programs is related to the interaction among three primary framework dimensions (Table 23).

Table 23

Conceptual Framework Dimensions

Dimension	Description
Teacher Use	Teachers' use of digital technology for their professional work and for instruction.
Student Access	Student access to digital technology.
Student Learning	Student ability to learn to use their devices for learning.

The *Teacher Use* dimension is supported by prior research on teacher technology use in schools, which has shown that teachers face extrinsic and intrinsic barriers when they try to use digital technology (Bingimlas, 2009; Ertmer, 1999); that teacher beliefs affect how teachers implement digital technology and use it for instruction (Riel & Becker, 2000; Tondeur et al., 2008); and that professional development has the potential to change teacher beliefs and practices with regard to digital technology use in the classroom (Harris & Hofer, 2011; Voogt et al., 2011). The research in this study confirms these findings as teachers who had more school support for the BYOD program had higher perceptions of the program, as did teachers who held a more constructivist-oriented view of learning.

The *Student Access* dimension, that is, asking students to provide their own access to technology by bringing a device, even if it is not required, may lead to inequitable access among students (Baule,

2012; Watters, 2012) with inequitable opportunity to learn or inequitable outcomes. Student access goes beyond affordability and includes any access situation that might affect a student's ability to participate in meaningful learning (Scherff & Piazza, 2008), such as situations where a student forgets to bring the device. This study confirms that addressing access and equity are important aspects in any BYOD program.

For the *Student Technology Learning* dimension, how students learn to use their devices for learning in the classroom where every student may have a different device has not been studied, but students can learn to use digital technologies with limited or no instruction (Lei & Zhao, 2008; Mitra et al., 2005; Negroponte, 2009; Papert, 1993). Furthermore, affordances designed into the devices students use can support student use of the devices (Gibson, 1977; Norman, 2002). In this study, teachers reported that students were able to learn to use their technology through working with each other.

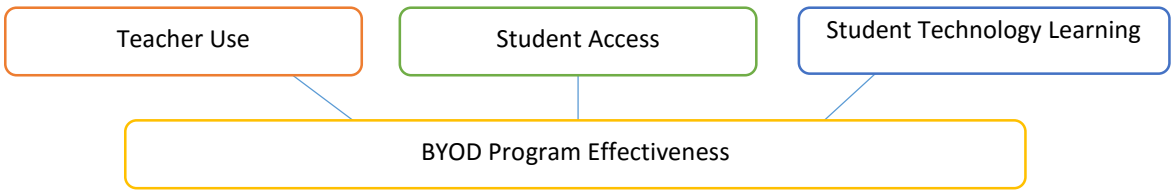

Figure 12. Conceptual framework dimensions and relationship to BYOD program effectiveness.

The three dimensions of the framework were derived from the literature, and their relationship to BYOD program effectiveness can be shown as a diagram (Figure 12). The research questions were each mapped to a framework dimension to illustrate how the conceptual framework and research questions interact (Figure 13). In light of the findings from this research, the diagram will be refined later in the chapter.

Findings

Several findings came from this research. First, the extent to which teachers incorporate student devices in instruction is overall related to their own beliefs and practices. However, the extent is

positively influenced by the school support for technology as well as by how the school implements the BYOD program. Second, most teachers believe BYOD can be equitable for all students, although fewer believed the program in their own school was equitable. Third, students can learn to use their devices for learning without direct instruction.

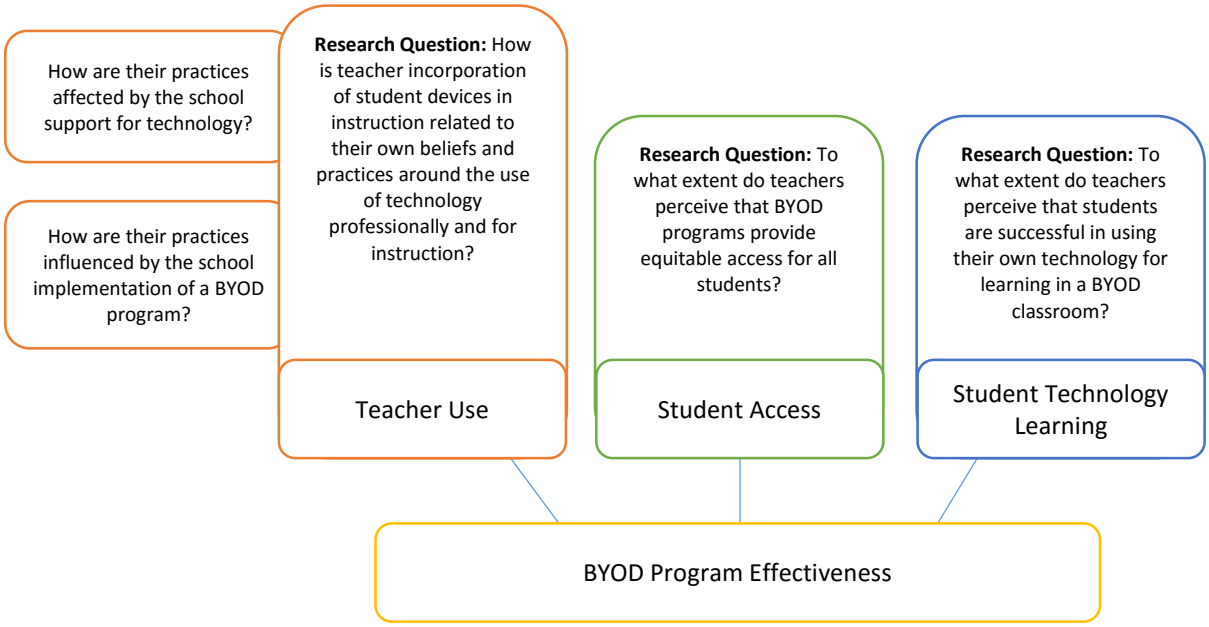

Figure 13. Relationship of research questions to conceptual framework dimensions.

Finding 1: Teacher use. The strongest correlation with Teacher Technology Use was that of Teacher Technology Use Frequency with their constructivist-compatible beliefs, which correlates with Riel and Becker (2000) and Tondeur et al. (2008). The school factor that had the largest positive correlation with teacher use frequency was available time, followed closely by overall Atmosphere. *Available Time* refers to time teachers have with students, time for planning BYOD, and time for BYOD discussions with colleagues. *Overall Atmosphere* refers to subject culture, knowledge and skills of students or other teachers, and action or influence of parents, community or administrators. As these factors became more positive, teachers tended to use technologies more frequently, and use a greater variety of technologies. This is consistent with the research on barriers (Ertmer, 1999; Ertmer et al.,

2012), which shows that as first order barriers (barriers external to the teacher) are lowered, teachers tend to use technology more.

Almost all teachers also reported a significant increase in the use of technology in the classroom in recent years, which coincides with the implementation of a BYOD program. Furthermore, teachers in the study had a positive attitude towards BYOD and believed it to be effective.

Finding 2: BYOD equity. Overall, most teachers (63%) believe that BYOD programs can be equitable for all students, although fewer (46%) believed that the program in their own school was equitable. This teacher belief contrasts with literature on equity where the focus is in providing similar resources to students and increasing access for students who have fewer resources (Baule, 2012; Watters, 2012). It is not that teachers did not believe student equity was unimportant. Rather, within the context of the BYOD program, they found that equity could be adequately served by having appropriate equipment for students to use in school if they did not have a device, or using partnering and sharing strategies where those without devices worked with those who did. Part of the view that equity can be served in a BYOD program may be that teachers perceived that students did not see difference in the types of devices students brought as an equity issue, which allayed the concerns of teachers. Smartphones were perceived by some as being the solution to equity as almost every student had one, even those with no Internet or computer access at home.

In some schools, the school provides a tablet to students, either for no charge or a small fee, but students are allowed to bring in their own devices as well. In these schools, teachers know that every student has a minimum capability with their equipment that will allow them to do the work. All of these approaches may have contributed to the finding that schools can implement BYOD equitably.

Finding 3: Student device learning. Students can learn to use their devices for learning without direct instruction. From the survey, approximately 80% of the teachers believe that students can learn from each other, and through working on assignments, how to use their devices. This correlates well

with the observation that people can learn to use various technologies without direct instruction (Lave & Wenger, 1991; Lei & Zhao, 2008; Mitra et al., 2005; Papert, 1993). This finding is not to imply that teachers were not intentional about students learning to use their devices. From the interviews, teachers had several strategies to help students, using techniques such as *ask three then me* (students are to ask three other students for help before asking the teacher), asking students who are familiar with a task to identify themselves for others, and encouraging web searching. Often students would take charge of their own learning without teacher intervention as teachers regularly had expectations that students would identify and resolve issues by working with other students. Overall, teachers did not view themselves as technology support but instead expected students to collaborate to solve their problems. Yet teachers would sometimes do one-on-one work with students to help them troubleshoot, even if the teacher was not familiar with a student's device. Yet, based on teacher positive perceptions of different devices in the classroom, they seldom viewed that work with a student as a burden.

When teachers create an environment where students take charge of learning to use their own device and can easily work with other students to solve their issues, direct instruction on how to use a device is not needed. Furthermore, teachers overall do not view the variety of devices in the classroom as a burden, and many like the fact that students bring in different devices.

Conceptual Framework Refinement

From the findings, the conceptual framework can be refined to indicate what conditions or factors are more likely to lead to effective BYOD programs as indicated by teacher attitude towards, and perception of, BYOD programs (*Figure 14*). Of particular interest is that when teachers create a collaborative classroom environment where students are encouraged to solve their technology problems by working with other students, students learn to use their devices from each other and from their assignments, and they seek and offer help as needed.

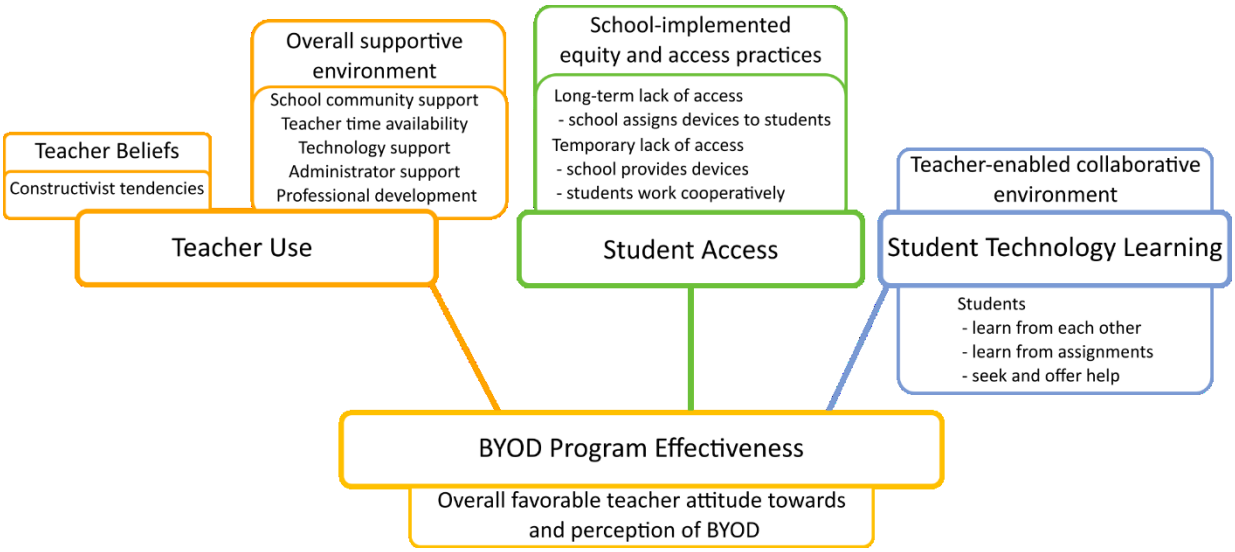

Figure 14. BYOD Framework illustrating factors in each of the three dimensions (teacher use, student access, and student technology learning) that contribute to teachers having an overall favorable perception of BYOD programs. Student actions under student technology learning occur naturally when the teacher enables a collaborative classroom environment.

Implications

General. A key implications of the study is that BYOD can be implemented equitably if schools have a way to provide suitable devices to students who are unable, for whatever reason, to provide their own. Such school-provided devices may be available either short-term (a day or a class) or long-term (a week, a semester, or a year). While a few of the teachers reported that they were able to have students without devices pair with students who had brought devices, this did not seem to be a widely accepted approach to equity. Based on these results, as districts and states are plan on ways to get more useable technology in student's hands, BYOD is a viable approach if equity and access issues are addressed prior to beginning the program. From the Project Tomorrow Speak Up survey, 64% of parents are willing to provide devices for their children (Project Tomorrow, 2015a). BYOD allows states and districts to demonstrate fiscal conservatism by not duplicating devices for students who are willing to provide their own, while also allowing scare resources to stretch further. However, for BYOD to be successful, schools will need a robust technology infrastructure that allows student devices to reliably connect to a school's broadband connection to the Internet.

One of the striking implications was what was not said. While this research survey did not specifically ask if schools attempted to manage the devices using virtual desktops or mobile device management tools, these were not mentioned in any of the open-response sections, nor did the topic come up in the interviews. Schools apparently are not going down the path of trying to manage devices or enforcing a uniform experience, which implies that schools do not need to devote extra resources to managing devices.

District and state policy. As mentioned earlier, BYOD has the potential to change the way funding challenges for powerful technology in the classroom are met. As states and schools struggle to find enough funds to provide for their students and allow the students to use powerful technology in the classroom, policy makers can consider BYOD as one way to help funds go further. In a typical one-to-one program, schools not only buy all of the devices, but they are responsible for maintaining, troubleshooting, and replacing all of the computers. Deploying numerous devices is labor and time intensive, and cost pressures tends to put the focus on purchasing quantity over capability. That is, schools may purchase less expensive and less capable devices that do not perform well because enough can be purchased for the students. Or schools and states may choose not to move forward with one-to-one programs because they do not see a sustainable way to address the total cost of ownership.

However, parents who have means have indicated a willingness to provide devices for their children to use in school for learning. A national survey in the United States in late 2014 showed that of the approximately 35,000 parents who responded, 64% were likely or somewhat likely to purchase a mobile device for their child to use at school if the school allowed its use. Furthermore, 61% were likely or somewhat likely or somewhat likely to want their child to be in a class where the students could use their own mobile devices when compared to an identical class where it was prohibited (Project Tomorrow, 2015a).

In the same survey, of the 66% of high school (grades 9-12) students that reported they had a personal laptop that was either provided by themselves or by their family, with only 24% reported using them at school. While middle school (grades 6-8) also reported a 66% personal family- or self-provided laptop, only 17% used them at school.

This willingness for parents to purchase devices and students to bring their own devices represents a large, untapped resource for schools. Furthermore, as parents are apparently willing to provide such devices even without their school explicitly explaining the benefits, schools that develop an outreach plan to parents could potentially increase the number of participants. Maintaining and replacing technology is expensive for schools— annual costs for a laptop computer issued to a student, without the cost of school technology personnel to administer the program, can be $300.00 or more when purchased at the school level rather than as an entire state program (State of Maine Department of Education, 2013). Even tablets can cost in excess of $200 per year. With BYOD, schools and states can instead focus their limited resources on providing devices for students who are unable to bring their own device.

One particular issue that U.S state and district policy makers will have to address if they wish to implement a BYOD program is the unsupported warning against such programs in the *2016 National Educational Technology Plan* (United States Department of Education Office of Educational Technology, 2016). That warning is similar to the criticism that teachers in the Bring Your Own Laptop pilot project (see Chapter 1, p. 2) received from others not involved in the pilot. The pilot project teachers found great value in their BYOD implementation, just as the majority of the participants in this research found value in their students bringing their own devices. Yet, for the pilot project, other educators, even those familiar with one-to-one programs, were skeptical of the approach where students had different devices. None of those who were skeptical had ever taught in a class where students brought their own devices. Research, such as this current study, may eventually help overcome an anti-BYOD initial bias.

Until then, actually teaching in a BYOD classroom may be necessary to fully understand benefits. Experience with BYOD may be the counter-argument to unsupported warnings.

Teacher role in student learning: A model. From this research, student ability to use their devices for new or unfamiliar tasks was seldom a challenge. While a few of the schools reported a technology class, other schools did not have such a class and most teachers did not report that they had to show students how to use their devices. Yet, almost all teachers reported that they helped students solve problems with their devices, which is different from showing students how to use their devices. Students who bring their own device almost invariably know how to use it, and they receive abundant help from other students for features and functions they may be unfamiliar with. Teachers no longer feel impelled to lead whole class instruction step-by-step in the basics, a time-consuming practice that only results in low-level learning and that may not transfer to other tasks. Instead, teachers can help students discover the capabilities of their devices as learning tools by identifying benefits for creation and learning that the devices provide. As students are bringing in technology knowledge, or gaining it without direct teaching, the students are effectively providing much of the Technological Knowledge (TK) that teachers were assumed to need in the Technological Pedagogical and Content Knowledge (TPACK) model discussed in Chapter 2. These conditions lead to a potential model for the teacher role in student learning and knowledge that will be illustrated through an example.

The first condition for developing the model is that students bring some knowledge about how to use their individual devices into the classroom with them. How they gained the knowledge, whether in a tech class, other BYOD classes, or from using the device at home is immaterial – what matters is that they have some knowledge. The second condition is that students work with each other in the context of the classroom and assignments to learn more about how to use their device to accomplish the tasks or goals before them. The third condition is that teachers encourage students to work together, and will allow time for students to explore. The model will focus on affordances of the devices, that is, the

knowledge in the world that complements the knowledge in the head (Norman, 2002), and the teacher's role in making unperceivable affordances perceivable.

Previous discussion in this research might imply that students can learn to use all of the affordances of their devices from each other, but that implication is based on an assumption that each of the affordances is perceivable to at least one student in the group. While many of the affordances of a device are perceivable, using Norman's (2002) term, many are not. If a teacher expects students to use these affordances, then the teacher likely has a responsibility to help the students perceive the affordances. The affordance of an automatic table of contents—a table of contents that automatically updates as the document is edited—in word processing and the affordance of electronic file organization provide examples of affordances that may not be perceivable to students.

As an example, in a BYOD environment, most students may bring devices that have word processing applications, or they may have access to cloud-based word processing applications such as is available through Google Drive® or Microsoft Office 365®. Most word processing applications depend on custom or convention for an affordance to be perceivable, such as for creating an automatic table of contents, and neophytes or non-expert users, unfamiliar with the appropriate custom or convention, may not perceive the cues of the affordance. That is, the affordance may be unperceivable to the user, and an unperceivable affordance is not an affordance at all (Still & Dark, 2013). Furthermore, most students first see a table of contents either on a printed page, in a book, or on a computer or tablet screen. In most of those situations, the table of contents and headings look identical to rest of the text except for font. Students may perceive that a table of contents is created by entering text just as for the body of the document; they are misled by the false affordance implied by the printed or screen copy.

Helping students learn to create an automatic table of contents is an instance where the teacher may need to take some action to make that affordance perceptible to the students, and make it perceptible enough that the students can effectively create the automatic table of contents. If all

students had the same devices, as in most one-to-one programs, the teacher might be tempted to give step-by-step instructions of how to create an automatic table of contents. However, just as in professional development where teachers are taught how to use technology tools rather than situating the technology within an authentic problem, or where children are trained to use simple strategies absent an authentic problem, this method would likely be somewhat ineffective (Brown, 1992; Harris et al., 2009). In a BYOD environment, where many different devices are in the classroom, the teacher is apt not to know the procedure to create an automatic table of contents on each device so the value of step-by-step instructions is minimized.

Instead, using the concept that students can learn to use their devices by working together, one approach to reveal the affordance would be for the teacher to inform students that most word processing applications can automatically create a table of contents and keep it updated. The teacher then challenges the students to work together to figure out how this can be done on their devices. Students who resolve the problem can be asked to share what they learned with the other students to help them resolve the problem.

Another example in which teachers may help students learn about their devices is to help students perceive the affordances offered by technology to organize documents and other work product files so that they can be stored and retrieved. Storage is usually easy—the users use the save function within whichever program they are using if the program does not automatically save. Finding the information later is where users may have difficulty. Some programs have powerful search features, assuming that the information has been saved in a common place, although sometimes the search feature does not lead to an appropriate document if the user cannot recognize the document. Here, the teacher can act in concert with students to help them begin to use and develop their own storage schema. As the students become more advanced, they can begin to understand how others may construct a storage schema as well as understand commonly used schema. The best storage schema is

one that students understand and will use, therefore helping students create appropriate storage schema implies that this can be a multi-year task as students engage in more complex work and need to update their storage schema to accommodate the increased complexity.

In other ways, teachers may also help students learn how get the various parts of their technology to work together for greater effect, such as the teacher who helps students understand how to use readability statistics and the thesaurus and dictionary embedded in word processing programs to develop strong, clearly written arguments (Ertmer et al., 2012). As the model has the teacher making unperceived affordances perceivable, that is, revealing the affordance, this model is the Teacher Affordance-Revelation (TAR) model.

While students can learn from other students many ways to use their devices in BYOD environments, the TAR model describes a role of the teacher in helping students gain the most learning by making unperceivable affordances perceivable.

Limitations of the Study

The study has several imitations that are a result of design, measurement, and sample. Design addresses the conception and scope of the study. Measurement addresses the accuracy of the measurement, and sample addresses effect that the participants in the study may have.

Design. The design is a triangulation study using both quantitative and qualitative information, but it is not longitudinal. The design was not intended to determine what actions would lead to an effective BYOD program, but rather to determine how teachers perceive the effectiveness of their current BYOD program for learning. The design also focused on teacher's perceptions of various aspects of BYOD and digital technology in learning rather than on direct measurement. For example, teachers responded to prompts about their perception of equity in BYOD. A research design that included students and parents may have yielded different perceptions of equity from those participants

Measurement. For the online portion of the survey, the mean time for a participant to complete the survey was a bit over seventeen minutes. While incomplete responses were dropped, the data was not scrubbed to remove responses that may have been completed without adequate participant attention, that is, the participant just checked boxes to get through the survey. As the interviews were semi-structured, any discussion not directly based on a prompt might have raised topics or issues that were common, but appeared unique because they were only mentioned by one participant.

Sample. In this study, not only did the participants self-select to participate in the research, but participants also needed strong internal motivation to complete the 172 prompts in the online survey. The strength of motivation is indicated by the fall-off rate of 50%, with 218 surveys started but 108 surveys completed. The survey had features intended to engage the intrinsic motivation of the participants, such as an opening message appealing to an altruistic nature of the participants in helping others professionally (Singer & Ye, 2013), as well as an offer of a contribution in exchange for completing the survey (Fan & Yan, 2010), but participants still needed enough motivation to complete the survey.

While teachers may have any level of perception of BYOD, either positive or negative, the replies in the survey showed that the perception of BYOD was strongly positive. This may be because most teachers are supportive of BYOD, or because teachers who had experience with BYOD but were not supportive of it had little interest in participating in research on the topic. As such, the survey may not apply to all teachers, but only those who tend to have a positive perception of BYOD.

Participants were recruited, which was either through messages in discussion groups and social networks where BYOD teachers were likely to hang out or through direct email to teachers identified through their participation in BYOD groups or other means, the survey would have primarily reached only those for whom being professionally engaged is part of their life. Professionally engaged teachers also tend to use technology more (Riel & Becker, 2000).

While this survey included public and independent schools in both North American and outside of North America, the common theme is that each teacher chose to invest the time to participate, which may indicate that, overall, the teachers had more time to consider participating in research than teachers who did not participate, and increasing available time is positively correlated with increased positive perceptions of BYOD. It may also indicate that more teachers participated from schools where BYOD was likely to have been successful compared to schools that had tried BYOD and then cancelled the program.

Inner-city schools or schools with high migrant populations may not have the same results with BYOD. In both cases, students in such schools may be more economically disadvantaged, or have more issues with personal safety or crime, than the students in the schools where teachers participated in this research. The result may be that such students are less able to bring a device, or are more likely to not bring a device due to fears of theft, robbery, or damage (Lowes & Luhr, 2008). This research did not ask for teachers to report traditional measures of socio-economic status for their school, nor is there a direct way of knowing much about the socio-economic status of the students of the teachers who participated in this research. While teachers in the interviews did occasionally refer to their students' economic status, none of those comments indicated that results were received from larger inner-city schools, which have a lower uptake of BYOD (Banister & Reinhart, 2015), or schools with a high migrant population. Results should be interpreted with care in those cases.

Furthermore, the survey did not directly examine student's perceptions of their BYOD program; any report of student perceptions was a teacher's interpretation of student perceptions. Also, while the teachers reported that students learned to use their devices effectively through assignments, on their own, and working with others, a definition for effectiveness was not provided so that teachers used their own understanding of effectiveness.

Areas for Further Study

Device capability. The capability of the device is one area for further study. In the interviews, several teachers mentioned that laptops were better than tablets as tablets were not as capable with multitasking, text input, communication between programs, and using various websites. While there may be *an app for that*, future studies could examine the extent to which the capability of a devices affects the efficiency and depth of learning.

Another area for device capability study is that of centrally managed devices examine extent that restricted-access managed devices, that is, devices that are managed by an IT staff and configured to prevent students from making some types of changes or accessing certain content or websites, are rendered more or less useful due to the locking devices.

Longitudinal BYOD benefits. Does participating in a BYOD program yield benefits in for students when they enter a post-secondary institution? Teachers did report that students knew how to use their own devices and learned more as time progressed. As colleges and universities tend to be BYOD, where students are expected to bring their own devices and use them for learning, the question becomes whether students who had learned to use their devices to create products demonstrating their learning would be more facile in a higher education setting than students do not have that opportunity. Those students could be compared against students who are given standard laptops or tablets in a one-to-one program, where all programs are loaded and the laptop is typically locked down to prevent the student from making changes.

Equity. While this research demonstrated that teachers believed that students perceived the difference in devices brought by students to be less of an issue than teachers had initially thought, further research could investigate the actual beliefs and perceptions of students in BYOD program. An area for further study would be to examine how families make the decision to provide a device to participate in a BYOD program. That is, do families that are not yet part of the digital generation see a

BYOD program start in their school, then purchase a device based on pressure from the child? Furthermore, do students who are from low income families actually acquire a device to benefit the school, themselves, and possibly their families? This research indicates that some do, but the extent to which a low income family purchases a device for a BYOD program was not studied. Potentially, if the purchased device is the first powerful Internet-enabled device in the family, the skills the student learns when using the device in school may transfer to the family.

Role of technology courses. While extensive evidence throughout this research shows that students learn to use their devices on their own, during the interviews five of the teachers mentioned that students took technology courses. The courses were a regular class or a *boot camp* (a session before the school year started where BYOD policies, procedures, and a few technology basics were introduced to students.) However, this project was not designed to provide information about the necessity or effectiveness of such programs in a BYOD environment. Further research into such courses may help schools determine if these make sense within their own BYOD program and, if so, how these courses might be effectively structured.

BYOD program design. The benefits or drawbacks of any one type of BYOD program were more difficult to determine as there were many different kinds of programs, from those that required a laptop —even in a public school—to those that just asked student to bring in anything. Developing an understanding of why many teachers like the fact that student have different devices may identify benefits of having different devices in the classroom. As such, studying the benefits and affordances that various BYOD programs provide may identify effective practices with BYOD as well as identify practices to be avoided.

Support requirements. When the school provides the devices, the school needs the same robust wireless and network infrastructure, and infrastructure support, as for BYOD. The school also needs the personnel and resources to support the individual devices, including break-fix services, device

setup and configuration, and ongoing support. If the school allows students to take school-owned devices home, many schools also filter the Internet connection on the device, which adds expense and complexity to device management. Further research could compare support, and hence cost, differences between schools with various types of BYOD programs and schools with one-to-one programs where the school provides all devices.

Also, as students bring in knowledge about how to use their devices, and are able to learn to use their devices working with each other, further research might help determine if students bringing their own devices saved instruction time as whole-class instruction on technology use targeted to the least knowledgeable or least cable student would be avoided.

Standardized test support. Standardized tests are a fact of life in modern schools, with the testing required by the No Child Left Behind Act of 2001 (NCLB; 2008), and even the recently reauthorized version, the Every Student Succeeds Act (ESSA; 2015), maintains testing requirements, albeit reduced from NCLB. Most standardized tests are now online, which requires a secure testing environment and devices compatible with the test software. Currently there are solutions for administering high-stakes online tests on the test-taker's own devices, such as the ExamSoft® software used for the American Bar Exam. Future research could determine the extent to which student devices can be suitable for testing. Students using their own devices for testing would reduce the need for schools to purchase devices primarily dedicated to testing. Such an approach would also eliminate the need of reclaiming school-owned devices from classrooms and students during the testing periods (from a week to a month) so that the devices could be used to give tests.

Conclusion

Students now use multiple devices in their personal life when they have them available, and allowing students to bring their own devices as learning tools, even when the school provides devices, can be an effective way to leverage technology in the classroom. BYOD programs that teachers perceive

as effective for learning address student access to devices by having suitable devices available for students who, for whatever reason, are unable to bring one with them. Successful programs also have robust wireless access within the school to support all of the devices and the school has an overall environment that supports teachers. BYOD programs can be a powerful way to make current and emerging technologies available to students while still providing equitable learning opportunities to all students.

But a recitation of findings about BYOD overlooks the meaning of what happened in those classrooms. Ignore the devices that students brought and the overarching theme was learning together. The students solved problems most often by working with other students or working with their teacher. While the teachers may have been involved in the solution, they understood that they did not contribute technical expertise so much as model learning for the students. The teachers demonstrated that learning required building on the knowledge that each person, student or teacher, brings to the activity.

For students and teachers to learn together in a technologically-enabled classroom, the teacher creates the conditions that allow each to share the knowledge they bring. As discussed in the TAR model (above, p. 116), students have some knowledge of how to use their personal device. Their knowledge may be incomplete, just as the knowledge of other students may be incomplete, but when students share, together they can do what no one of them can do alone. Furthermore, because students are operating with their personal devices, their own understanding and knowledge about that device is greater than for any knowledge they would have about a school-provided device, particularly when a school enforces device consistency by locking it down. Outside of school, students work, play, explore, and collaborate on their personal device to satisfy their own needs. They put on personalized cases, covers, or stickers, and download apps and software. Those devices become part of them. When students bring their devices into a classroom, they are not just bringing a device. They are bringing an

artifact that is not only a tool, but a visible sign of the extra knowledge the student carries, knowledge that would not exist with a school-owned device. BYOD is not just about allowing students to Bring Your Own Device, but about allowing students to Bring Your Own Knowledge to school.

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APPENDIX A

Online Survey

The survey was administered through SurveyGizmo (an online survey service) and consisted of several screens that the participant completed sequentially. In order to assure the anonymity of the data, location services, which usually includes recording the Internet Protocol (IP) address, browser type, and any other information associated with the device the participant uses, was disabled for all surveys associated with this research. For privacy and security, the survey was only accessible through an encrypted secure socket layer (SSL) link.

The first screen qualified potential participants by asking them questions to determine if they had experience in a school with a BYOD program, with at least half of their teaching time being in classes where students had their own devices. If they did not meet these criteria, they were disqualified, and their next screen thanked them for wanting to participate but informed them that the survey had filled its quota for their category.

The survey allowed participants to stop and resume so they could continue if they were interrupted.

Survey Key

As the survey was designed to be presented online, the layout below uses some conventions to indicate the elements online. The key is:

[Brackets surrounding text are comments about survey flow or requirements.]

Italicized font indicates the prompt for a question, which may be common to additional questions.

An asterisk (*) indicates a required question, which only applies to qualification questions.

Screen header. Indicates the header text at the top of the screen.

Response Options: Indicates the scale used for the following items. Selections are made with radio buttons that only allow one response per question.

- Discrete questions are indicated with bullets, followed by their (identification code in parentheses). The participants do not see the identification codes.

[ ] indicates an option to choose one or more or more (checkbox);

_____ indicates a short text entry (one line) or long text (two lines).

Screen 1: Pre-qualification

Screen header. Welcome!

I am conducting research on how schools and teachers implement a Bring Your Own Device (BYOD)—sometimes known as Bring Your Own Technology (BYOT)—programs and how teachers perceive the programs. If you have experience in a BYOD classroom, please consider participating. I will also make a small donation to charity for each survey completed - details on the next page.

*Are you currently teaching or have you taught in an elementary, secondary, or young adult vocational school with a BYOD program?**

( ) Yes ( ) No

*Do you or did you spend more than half of your time teaching classes where students bring their own devices?**

( ) Yes ( ) No

Screen 1A: Disqualification

Thank you for wanting to take the survey, but the survey has filled its quota in this category.

[This screen is only presented to those who answer *No* to either question in screen 1. The survey terminates after this screen.]

Screen 2: Informed Consent

Screen header. Informed Consent

Dear Teacher,

This page is the Informed Consent information that is required to be presented to participants prior to taking the survey. The link to continue the survey is at the bottom of this page.

My name is Derrel Fincher, and I am a Doctoral student in the Learning Technologies program at Pepperdine University. The professor supervising my work is Dr. Margaret Riel. The title of my research study is *Teacher Use and Perceptions of the Successes and Challenges of Bring Your Own Device (BYOD) Programs* and is being done as partial fulfillment of the requirements for my Doctoral degree.

Purpose of Research Study. I am conducting this study to determine how schools and teachers implement a BYOD program and the issues, challenges, and benefits that teachers find when students bring their own device to use in the classroom. The goal is to understand successful and not-so-successful practices in BYOD programs so that other teachers and schools considering a BYOD program will have better information. Your experiences working in a school with a Bring Your Own Device (BYOD)—sometimes known as a Bring Your Own Technology (BYOT)—program will help other schools and teachers as they develop their own BYOD programs.

Procedures. Participation in this research study will involve completing a 20-25 minute survey. The questions will ask you about your professional use of digital technologies, how you use digital technologies with your students, how you accommodate student-owned devices in your classroom and how your school or districts provides support for your use of digital technologies and student-owned devices.

Potential Risks. This research has minimal risks, primarily the loss of time filling out the survey.

Potential Benefit. Completing the survey may help you reflect on your practices and you will have the option of receiving a summary of teachers' perceptions of the benefits and challenges of programs like yours.

Voluntary/right to deny or withdraw from participation. Your participation in the research study is completely voluntary, and you have the right to stop at any time, or skip any questions, with no negative consequences to you.

Anonymity / Confidentiality. Your survey responses are anonymous. Any contact information, should you choose to provide it to receive results of the study, will be collected separately, kept separately from the survey and will be confidential. You do not need to provide contact information. The confidentiality of my records will be maintained in accordance with applicable state and federal laws.

The results of this research study will be summarized as a whole, as so no persons will identify you.

Contact information for questions or concerns. If you have further questions regarding this research, you may contact me, the primary investigator, Derrel Fincher at: derrel.fincher@pepperdine.edu, _____ or my faculty supervisor, _____ at _____, _____. If you have questions about your rights as a research participant, you may contact _____, Chairperson of the GPS IRB at Pepperdine University at gpsirb@pepperdine.edu, 310-568-5753.

On-line consent. By clicking on the *Continue to Survey* button below, you agree to participation in this research study. If you would like documentation of your participation in this research, you may print this page.

[The participant must click the *Continue to Survey* button as instructed in the Informed Consent in order participate in the survey.]

Screen 3: Survey invitation and explanation

Screen header. Introduction

Thank you for participating! As a way to support effective charities, I will donate three dollars to your choice of *Save the Children* or *Books for Africa* for a completed survey. Both charities help children

and are top-ranked in the *Charity Navigator*. [Italicized content is hyperlinked to the website for the organization.]

Survey Overview. This survey explores your experience in working with multiple forms of technology brought by students into the classroom. It is divided into five sections, each on a separate page.

1. Your knowledge and use of digital technology,
2. Instructional use of digital technology,
3. Bring your own device (BYOD) program specifics,
4. Factors supporting your technology use in the classroom,
5. Demographics.

You can save and continue the survey at any time by clicking the Save and continue survey later bar at the bottom of each screen. Total survey time is generally fifteen to twenty minutes.

At the end of the survey you will have an opportunity to continue the study by volunteering to participate in an interview. Your experiences are valuable and will help others.

Thank you again for participating!

Derrel Fincher

derrel.fincher@pepperdine.edu

Screen 4: Teacher Knowledge and Use of Digital Technology

Screen header. Your Knowledge and Use of Digital Technology Section 1 of 5

Please rate your ability to use digital technology in the classroom:

Response Options: No Knowledge**,** Limited Knowledge**,** Medium Knowledge**,** Good Knowledge**,** Very Good Knowledge

- Use computers and office software. (tk_a1)
- Perform Internet research. (tk_a2)

- Create slide shows. (tk_a3)
- Create online units on a learning platform (e.g., Moodle, Edmodo, Canvas, Blackboard). (tk_a4)
- Discuss with students issues emerging from digital technology (e.g., data protection, copyright, personal security or inappropriate content). (tk_a5)
- Your overall knowledge to make meaningful use of digital technologies for teaching. (tk_a6)

Please rate your knowledge in helping students do the following:

Response Options: No Knowledge**,** Limited Knowledge**,** Medium Knowledge**,** Good Knowledge**,** Very Good Knowledge

- Create their own presentations with graphics and video (tk_b1)
- Find and use appropriate and credible Internet resources and databases. (tk_b2)
- Create simple digital documents with texts and images. (tk_b3)
- Create interactive multimedia products. (tk_b4)
- Communicate appropriately over the Internet through multiple means (e.g, via email, forum, blogging, instant messaging). (tk_b5)
- Use learning software (e.g., vocabulary programs, scientific simulations). (tk_b6).

Please agree or disagree with each statement.

Response Options: Strongly Disagree**,** Disagree**,** Neither Agree Nor Disagree**,** Agree**,** Strongly Agree

- I know how to use digital technologies to enhance students' learning. (tk_c1)
- My unit planning includes how I will integrate digital technologies. (tk_c2)
- I routinely embed digital technologies into student activities and projects. (tk_c3)
- I discuss the use of digital media with my teaching colleagues at school. (tk_c4)

In your judgment, how committed are the following people to the use of digital technology and the Internet for digital learning in their school(s)?

Response Options: Not At All**,** Little**,** Somewhat**,** Strongly**,** Very Strongly**,** N/A

- District administrators (tk_d1)
- School administrator(s) (tk_d2)
- School Board (tk_d3)
- Technology Directors (tk_d4)
- Other (tk_d5)

How often do you…

Response Options: Never, Yearly, Monthly, Weekly, Daily

- use a computer or the Internet in lesson preparation? (tk_e1)
- use a computer for professional, organizational and administrative purposes? (tk_e2)
- use the Internet in instruction? (tk_e3)
- have your students use their own devices in the classroom? (tk_e4)
- have the students in your classroom work on the Internet? (tk_e5)
- give homework that needs to be done using digital technologies? (tk_e6)
- work with your students on an Internet Learning platform (e.g., Moodle, Edmodo, Canvas, Blackboard)? (tk_e7)
- work with your students on other Internet platforms (e.g., blogs, social networks, wikis)? (tk_e8)
- raise awareness in your students of potential pitfalls or hazards on the Internet? (tk_e9)
- help your students understand the digital media landscape? (tk_e10)

Screen 5: Student Use of Digital Technology

Screen header. Student Use of Digital Technology Section 2 of 5

How often do your students use the following digital technologies in the classroom to support their learning?

Response Options: Never, Yearly, Monthly, Weekly, Daily

- View videos. (su_a1)
- Use educational software or tutorials. (su_a2)
- Do word processing/writing. (su_a3)
- Create spreadsheets and databases. (su_a4)
- Play educational games or simulations. (su_a5)
- Use drawing and graphics programs. (su_a6)
- Program or write code. (su_a7)
- Practice keyboarding. (su_a8)
- Evaluate and cite Internet resources. (su_a9)

How often do your students use the following digital technologies in the classroom to support their learning?

Response Options: Never, Yearly, Monthly, Weekly, Daily

- Present something on the projector, such as a presentation (PowerPoint, Prezi, etc.). (su_b1)
- Connect with others over the Internet. (su_b2)
- Present or publish their work online. (su_b3)
- Develop and design online content. (su_b4)
- Blog to present their work or content they have learned. (su_b5)
- Connect with others on social media (e.g., Facebook, twitter). (su_b6)
- Collaborate with others on joint projects. (su_b7)
- Share content they have created with others on social media (e.g., Facebook, Twitter, Tumblr, Pinterest). (su_b8)

In my classes, students learn…

Response Options: Almost Never**,** Rarely**,** Sometimes**,** Often**,** Almost Always

- about the world outside of school. (su_c1)
- that new knowledge is linked with student questions or experiences. (su_c2)
- the importance of what they have learned for outside of school. (su_c3)
- that school-based knowledge does not always provide an answer. (su_c4)
- that knowledge is influenced by cultural values and opinions. (su_c6)

In my classes, students…

Response Options: Almost Never**,** Rarely**,** Sometimes**,** Often**,** Almost Always

- feel safe questioning what or how they are being taught.. (su_d1)
- help me plan what they will learn. (su_d3)
- help me assess how well they are learning. (su_d4)
- help me decide what activities are appropriate. (su_d5)
- interact with each other in the classroom.. (su_d6)
- discuss how to solve tasks with each other. (su_d7)
- explain their ideas to other students. (su_d8)

In recent years, my frequency of technology use in the classroom has…(su_e1)

Response Options: decreased significantly**,** decreased slightly**,** remained about the same**,** increased slightly**,** increased significantly

Screen 6: BYOD Specifics

Screen header. Bring Your Own Device (BYOD) Program Specifics Section 3 of 5

Please indicate your agreement level with the statements: BYOD is…

Response Options: Strongly Disagree**,** Disagree**,** Neither Agree Nor Disagree**,** Agree**,** Strongly Agree

- exciting. (by_a1)
- more trouble than it is worth. (by_a2)

Please agree or disagree with the statements: With BYOD…

Response Options: Strongly Disagree**,** Disagree**,** Neither Agree Nor Disagree**,** Agree**,** Strongly Agree

- I like seeing my students discover what they can do with their devices. (by_b1)
- I like that my students have different devices. (by_b2)
- our school provides appropriate support for BYOD in my classroom. (by_b3)
- I am effective with class management when students have their devices. (by_b4)
- students behave more appropriately in class than without BYOD. (by_b5)
- students can learn from each other how to use their devices **effectively**. (by_b6)
- teachers should know how to use each student device. (by_b7)
- Students can learn to use their devices **effectively** through working on assignments. (by_b8)

Please select the features of BYOD program at your school. Students are…

[ ] **encouraged** to bring whatever they have. (by_c1)

[ ] **encouraged** to bring laptops or a more powerful computer. (by_c2)

[ ] **encouraged** to bring a tablet (iPad or similar) or more powerful device. (by_c3)

[ ] **required** to bring laptops or more powerful computer. (by_c4)

[ ] **required** to bring a tablet (iPad or equivalent) or more powerful device. (by_c5)

Thinking about your students and the BYOD program, choose your best estimate for students who…

Response Options: None or almost none, Less than 1/3, Between 1/3 and 2/3, More than 2/3, Almost all or all, Don't Know

- have a home Internet connection. (by_d1)
- bring laptop-type computers. (by_d2)

- bring tablets (iPads or similar). (by_d3)
- bring smart phones. (by_d4)
- bring other types of devices capable of accessing the Internet. (by_d5)
- routinely have **more than** one device capable of accessing the Internet with them. (by_d6)
- routinely do **not** bring at least one device with them. (by_d7)

When a student does not have a device capable of accessing the Internet, how often does a student…

Response Options: Never**,** Rarely**,** Sometimes**,** Often**,** Very Often or always

- **not** have access to any device for the period (by_e1)
- work with someone who has a device. (by_e2)
- borrow a device from another student. (by_e3)
- use a school-owned tablet (iPad or similar). (by_e4)
- use a school-owned laptop. (by_e5)
- use a school-owned desktop in the room. (by_e6)
- go to a computer lab or other room to use a computer or tablet. (by_e7)
- Other (comment) (by_e8)

Thinking about your students and the devices they bring to class, how often does every student bring at least one device…

Response Options: Never**,** Rarely**,** Sometimes**,** Often**,** Very often or always

- capable of accessing the Internet? (by_f1)
- that is the same size or larger than a tablet (iPad or equivalent)? (by_f2)

When your students do not know how to do a task, with their device, how often do the following happen?

Response Options: Never**,** Rarely**,** Sometimes**,** Often**,** Very often or always

- The student does not learn to do the task. (by_g1)

- The student searches the Internet for help. (by_g2)
- You help the student. (by_g3)
- The student independently seeks help from other students. (by_g4)
- Other students offer to help the student. (by_g5)
- You ask for technical assistance from others not in the classroom. (by_g6)
- Other (by_g7)

Please agree or disagree with each statement.

Response Options: Strongly Disagree**,** Disagree**,** Neither Agree Nor Disagree**,** Agree**,** Strongly Agree

- BYOD programs can be implemented in such a way as to address equity among students. (by_h1)
- At our school, BYOD has been implemented in such a way as to address equity among students. (by_h2)

Please provide information about whether or not…

student equity is addressed in your BYOD program and how it is addressed. (by_j1)

_____

_____

Please provide information about whether or not …

the BYOD program in your school is effective for your students. (by_k1)

_____

_____

Choose one location between each adjective pair to indicate how you feel about BYOD. BYOD is…

Suffocating ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 fresh (by_m1)

dull ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 exciting (by_m2)

unlikeable ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 likeable (by_m3)

unhappy ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 happy (by_m4)

How long have any teachers in your school been allowing students to use their own devices in the classroom? (by_n2)

Response Options: Started this year, 1 year, 2 years, 3 years, 4 or more years

Is your school's or school district's BYOD policy…

Response Options: No, Yes

- written? (by_p1)
- available through the Internet for parents and students? (by_p2)

If you were to talk to prospective parents about your BYOD program, what would you tell them? (by_q1)

_____

_____

Screen 7: Factors Supporting Technology Use

Screen header. Factors Supporting Your Technology Use in the Classroom Section 4 of 5

When thinking about the digital technology infrastructure at your school, what is the availability of…

Response Options: Very Poor**,** Poor**,** Fair**,** Good**,** Very Good

- computers for teachers? (sf_j1)
- laptops or tablets (iPad or similar) or teachers? (sf_j2)
- school-provided computers or tablets (iPad or similar) for students? (sf_j3)
- good wireless Internet? (sf_j4)
- fast Internet? (sf_j5)
- basic display technology (e.g., digital projectors, interactive white boards? (sf_j6)
- advanced display technologies (e.g., 3-D projectors or displays, interactive tables)? (sf_j7)
- technical support? (sf_j8)

When thinking about the support for digital technology at your school, what is the availability of…

Response Options: Very Poor**,** Poor**,** Fair**,** Good**,** Very Good

- Instructional support for integrating digital technologies into classes? (sf_k1)
- Training sessions on how to use hardware and software. (sf_k2)
- Professional development sessions on how to integrate digital technologies into lessons. (sf_k3)
- An academic support person able to come into a class to model use of digital technologies with students. (sf_k4)
- Online support (e.g., FAQ, school or district help documents online, online discussion groups or email lists)? (sf_k5)
- Informal guidance from colleagues (sf_k6)

Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom.

Response Options: Strongly Hinders**,** Hinders**,** Neither Hinders nor Helps**,** Helps**,** Strongly Helps**,** N/A

- Technology support (sf_m1)
- Technology reliability (sf_m2)
- Internet availability (sf_m3)
- Wireless Internet availability (sf_m4)
- Overall technology access (sf_m5)
- State standards (sf_m6)
- Standardized assessments (sf_m7)
- Overall funding (sf_m8)
- Available time with students (sf_q1)

- The number of students who bring a device (sf_p1)
- Students have a variety of devices (sf_p2)

Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom.

Response Options: Strongly Hinders**,** Hinders**,** Neither Hinders nor Helps**,** Helps**,** Strongly Helps**,** N/A

- The culture of the subject you teach (sf_n1)
- Time to plan BYOD implementation. (sf_q2)
- Time available to discuss BYOD issues with other teachers (sf_q3)
- Other teachers' attitudes and beliefs (sf_n2)
- Your own knowledge and skills (sf_r1)
- Your own attitudes and beliefs (sf_r2)
- Student knowledge and skills (sf_n3)
- School or district administration (sf_n4)
- Parents (sf_n5)
- Community (sf_n6)

Please agree or disagree with the following statement:

Response Options: Strongly Disagree**,** Disagree**,** Neither Agree Nor Disagree**,** Agree**,** Strongly Agree

- Our school has an appropriate written policy on the use of digital technology. (sf_s1)

Screen 8: Demographics

Screen header. Basic information about you and your professional background. Section 5 of 5

School Type

Response Options: Public**,** Independent - Secular**,** Independent - Religious**,** Public Charter**,** Other

- School Type (de_b1)

School Location

Response Options: Urban, Suburban, Town, Rural, Remote, International (non-North America), Other

- School Location (de_b2)

Response Options: Yes, No

- Is your school in North America? (de_b2a)

How many years have you been…

Response Options: 0-2**,** 3-5**,** 6-10**,** 11-15**,** More than 15**,** N/A

- teaching in schools? (de_c1)
- using digital technologies professionally? (de_c2)

What is your main teaching responsibility?

Response Options: Pre-primary**,** Primary / Elementary**,** Middle School / Junior High**,** High School**,** Vocational / Career Ed.

- What school level do you mainly teach? (de_d1)

What subjects do you teach?

[ ] Elementary self-contained (de_e1)

[ ] Elementary - other (de_e2)

[ ] Computer Science or Computer media (de_e3)

[ ] English/Language Arts (de_e5)

[ ] Other Language (de_e6)

[ ] History or Social Studies (de_e7)

[ ] Mathematics (de_e8)

[ ] Performing Arts (de_e9)

[ ] PE (de_e10)

[ ] Science (de_e11)

[ ] Visual Arts (de_e12)

[ ] Other (please List) (de_e13) _____

Are there any comments you want to share about your responses or the survey?

_____

_____

Thank you for completing the survey! Which charity would you like me to donate to?

( ) Save the Children

( ) Books for Africa

( ) Equally to Both

When you click the Exit Survey button below, you will be taken to a page where you can sign up to receive a summary of the research and to volunteer to participate in an interview. [Clicking the Exit Survey button closes the survey and takes the participant to a separate survey for the final information. This is done so that the survey responses have no identifying information associated with them.]

Survey 2, Screen 1: Interview Request

Screen header. Almost Done!

[In order to select interview participants, information for School Type, School Level, and Subjects will be passed to Survey 2. In the event that interview participants are recruited separately, that is, without going through the previous survey, they will be presented Survey 2 with those questions available prior to the next question.],

Please consider possibly participating in a short interview to help continue this research. If you are available for such an interview, please check the box and add your email address below. Your insights can help other teachers and schools. (ContactReasons)

[ ] Yes, I am willing to participate in a short interview. (interview)

[ ] Yes, I would like to receive a summary of the research after analysis is completed. (summary)

[ ] Yes, I would like to know the total donated to charity. (charity)

Email address

_____ (email)

What is your main teaching responsibility?

[The following questions only appear if the participant selects the answer, "Yes, I am willing to participate in a short interview.]

Response Options: Pre-primary**,** Primary / Elementary**,** Middle School / Junior High**,** High School**,** Vocational / Career Ed.

- What school level do you mainly teach? (de_d1)

School Type

Response Options: Public**,** Independent - Secular**,** Independent - Religious**,** Public Charter**,** Other

- School Type (de_b1)

School Location

Response Options: Urban, Suburban, Town, Rural, Remote, Other

- School Location (de_b2)

Survey 2, Screen 1: Thank You!

Thank you for participating in this BYOD survey. Your responses will ultimately help schools do a better job of incorporating student-owned devices in the classroom. If you asked for a summary of the results of the research, you will receive them after I complete the research.

APPENDIX B

Online Survey Question Development

This appendix presents a cross reference between questions in the survey and sources that were either an existing instrument or concepts from a discrete reference. Permission by the original authors was obtained for any questions taken from existing survey instruments (Appendix H). The information is shown in the same order as the survey questions are presented on the survey, with the research question mapping shown in the first column and the identification codes mapping shown in the first column. The first two characters of the identification code indicate the section that the question is in, and also indicate the table where the information can be found. The mappings are:

- TK: Teacher Knowledge and Use of Digital Technology (Table B1)
- SU: Student Use of Digital Technology (Table B2)
- BY: Bring Your Own Device Program Specifics (Table B3)
- SF: Factors Supporting Technology Use (Table B4)
- DE: Demographics (Table B5)

The information presented is the research question that the survey question is intended to address; the survey question as used in the survey; the primary reference source, whether the information came from an existing instrument (I) or as concepts from a discrete reference (R); and the original wording if the question came from an existing survey. A (T) after the original wording indicates that the question was translated from German by this researcher, e.g., “Please rate your knowledge of using digital media in the classroom. [Your knowledge regarding computers and standard software (e.g., operating system, office functions).](T).” Questions with no indicated source, instrument (I) or discrete reference (R), were developed for this survey.

Many of the survey questions have a common prompt followed by a specific question. The common prompt is first and the specific question follows in brackets, e.g., “Please rate your ability to use digital technology in the classroom: [Use computers and office software.]”

Research Questions

1. How is teacher incorporation of student devices in instruction related to their own beliefs and practices around the use of technology professionally and for instruction?
    - How are their practices affected by the school support for technology?
    - How are their practices influenced by the school implementation of a BYOD program?
2. To what extent do teachers perceive that BYOD programs provide equitable access for all students?
3. To what extent do teachers perceive that students are successful in using their own technology for learning in a BYOD classroom?

Table B1

Teacher Knowledge and Use of Digital Technology

RQ	ID	Survey Question (Teacher Knowledge and Use of Digital Technology)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation)
1	tk_a1	Please rate your ability to use digital technology in the classroom: [Use computers and office software.]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [Your knowledge regarding computers and standard software (e.g., operating system, office functions).](T)
1	tk_a2	Please rate your ability to use digital technology in the classroom: [Perform Internet research.]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [Your use of Internet browsers (e.g., perform Internet research, set bookmarks, etc.)](T)
1	tk_a3	Please rate your ability to use digital technology in the classroom: [Create slide shows.]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [Your presenting with a projector (e.g., PowerPoint , websites , videos)](T)
1	tk_a4	Please rate your ability to use digital technology in the classroom: [Create online units on a learning platform (e.g., Moodle, Edmodo, Canvas, Blackboard).]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [Using a learning platform to create and present learning units.](T)

(continued)

1	tk_a5	Please rate your ability to use digital technology in the classroom: [Discuss with students issues emerging from digital technology (e.g., data protection, copyright, personal security or inappropriate content).]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [With the students about problems / dangers of new media (e.g., data protection , copyright , rip-offs , violence , pornography)](T)	(co
1	tk_a6	Please rate your ability to use digital technology in the classroom: [Your overall knowledge to make meaningful use of digital technologies for teaching.]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [Your overall knowledge and ability to meaningfully use the computer for teaching](T)	
1	tk_b1	Please rate your knowledge in helping students do the following: [Create their own presentations with graphics and video]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [Help students create their own presentations (e.g., slides with graphics and video)](T)	
1	tk_b2	Please rate your knowledge in helping students do the following: [Find and use appropriate and credible Internet resources and databases.]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [To coach and guide students in research using the Internet and databases (e.g., selection of home pages, search terms, assessment of valid sites, etc.)](T)	
1	tk_b3	Please rate your knowledge in helping students do the following: [Create simple digital documents with texts and images.]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [To coach and guide students in producing simple digital documents (texts, images, etc.)](T)	
1	tk_b4	Please rate your knowledge in helping students do the following: [Create interactive multimedia products.]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [To coach and guide students in producing interactive multimedia documents (websites, audio files, movies, etc.)](T)	
1	tk_b5	Please rate your knowledge in helping students do the following: [Communicate appropriately over the Internet through multiple means (e.g., via email, forum, blogging, instant messaging).]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [Enabling students to communicate and moderate their communications over the Internet (e.g., via e-mail, forum, chat, etc.)](T)	
1	tk_b6	Please rate your knowledge in helping students do the following: [Use learning software (e.g., vocabulary programs, scientific simulations).]	(Petko, 2012) (I)	Please rate your knowledge of using digital media in the classroom. [Engage students with learning or simulation software (e.g., vocabulary, scientific simulations)](T)	
1	tk_c1	Please indicate your level of agreement or disagreement with each statement. [I know how to use digital technologies to enhance students' learning.]	(Prestridge, 2012) (I)	I don't know how to use ICT to enhance children's learning in my classroom.	
1	tk_c2	Please indicate your level of agreement or disagreement with each statement. [My unit planning includes how I will integrate digital technologies.]	(Prestridge, 2012) (I)	As I plan the next unit of work I think about how I will integrate ICT.	
1	tk_c3	Please indicate your level of agreement or disagreement with each statement. [I routinely embed digital technologies into student activities and projects.]	(Prestridge, 2012) (I)	ICT activities are part of larger on-going tasks rather than explicit ICT focused lessons.	
1	tk_c4	Please indicate your level of agreement or disagreement with each statement. [I	(Petko, 2012) (I)	Your opinion on the use of computers in the classroom [I want to trade with my	

(continued)

		discuss the use of digital media with my teaching colleagues at school.]		colleagues about who is working on what aspects of the ICT curriculum supplement.](T)
1a	tk_d1	In your judgment, how committed are the following people to the use of digital technology and the Internet for digital learning in their school(s)? [District administrators]	(Petko, 2012) (I)	How much are the following management positions / people committed to the use of computers and the Internet at their school? [cantonal education authorities](T)
1a	tk_d2	In your judgment, how committed are the following people to the use of digital technology and the Internet for digital learning in their school(s)? [School administrator(s)]	(Petko, 2012) (I)	How much are the following management positions / people committed to the use of computers and the Internet at their school? [local authorities](T)
1a	tk_d3	In your judgment, how committed are the following people to the use of digital technology and the Internet for digital learning in their school(s)? [School Board]	(Petko, 2012) (I)	How much are the following management positions / people committed to the use of computers and the Internet at their school? [school board](T)
1a	tk_d4	In your judgment, how committed are the following people to the use of digital technology and the Internet for digital learning in their school(s)? [Technology Directors]	(Petko, 2012) (I)	How much are the following management positions / people committed to the use of computers and the Internet at their school? [ICT administrators](T)
1a	tk_d5	In your judgment, how committed are the following people to the use of digital technology and the Internet for digital learning in their school(s)? [Other]	(Petko, 2012) (I)	How much are the following management positions / people committed to the use of computers and the Internet at their school? [Other - Please answer the following question](T)
1	tk_e1	How often do you… [use a computer or the Internet in lesson preparation?]	(Petko, 2012) (I)	How often in your work as a teacher, in total, is on the computer? [How often do you use computers or the Internet for lesson preparation?](T)
1	tk_e2	How often do you… [use a computer for professional, organizational and administrative purposes?]	(Petko, 2012) (I)	How often in your work as a teacher, in total, is on the computer? [How often do you use computers for professional organization and administrative purposes?](T)
1	tk_e3	How often do you… [use the Internet in instruction?]	(Petko, 2012) (I)	How often in your work as a teacher, in total, is on the computer? [How often do you use the Internet in your classroom?](T)
1	tk_e4	How often do you… [have your students use their own devices in the classroom?]	(Petko, 2012) (I)	How often in your work as a teacher, in total, is on the computer? [How often do students work on the computer in your classroom?](T)
1	tk_e5	How often do you… [have the students in your classroom work on the Internet?]	(Petko, 2012) (I)	How often in your work as a teacher, in total, is on the computer? [How often do students work on the Internet in your classroom?](T)
1	tk_e6	How often do you… [give homework that needs to be done using digital technologies?]	(Petko, 2012) (I)	How often in your work as a teacher, in total, is on the computer? [How often do you give homework that has to be done using the computer?](T)

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1	tk_e7	How often do you… [work with your students on an Internet Learning platform (e.g., Moodle, Edmodo, Canvas, Blackboard)?]	(Petko, 2012) (I)	How often in your work as a teacher, in total, is on the computer? [How often do you work with your students on an Internet learning platform (e.g., Educanet , Moodle , etc.)?](T)
1	tk_e8	How often do you… [work with your students on other Internet platforms (e.g., blogs, social networks, wikis)?]	(Petko, 2012) (I)	How often in your work as a teacher, in total, is on the computer? [How often do you work with your students on other Internet platforms (e.g., blogs, social networks, wikis)?](T)
1	tk_e9	How often do you… [raise awareness in your students of potential pitfalls or hazards on the Internet?]		
1	tk_e10	How often do you… [help your students understand the digital media landscape?]		

Table B2

Student Use of Digital Technology

RQ	ID	Survey Question (Student Use of Digital Technology)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
3	su_a1	How often do your students use the following digital technologies in the classroom to support their learning? [View videos.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [To view videos or films](T)
3	su_a2	How often do your students use the following digital technologies in the classroom to support their learning? [Use educational software or tutorials.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [For educational software](T)
3	su_a3	How often do your students use the following digital technologies in the classroom to support their learning? [Do word processing/writing.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [for text processing](T)
3	su_a4	How often do your students use the following digital technologies in the classroom to support their learning? [Create spreadsheets and databases.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [For spreadsheets or databases](T)
3	su_a5	How often do your students use the following digital technologies in the classroom to support their learning? [Play educational games or simulations.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [For games](T)
3	su_a6	How often do your students use the following digital technologies in the classroom to support their learning? [Use drawing and graphics programs.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [For drawing](T)

RQ	ID	Survey Question (Student Use of Digital Technology)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
3	su_a7	How often do your students use the following digital technologies in the classroom to support their learning? [Program or write code.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [For programming](T)
3	su_a8	How often do your students use the following digital technologies in the classroom to support their learning? [Practice keyboarding.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [For keyboarding](T)
3	su_a9	How often do your students use the following digital technologies in the classroom to support their learning? [Evaluate and cite Internet resources.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [For Internet research](T)
3	su_a10	How often do your students use the following digital technologies in the classroom to support their learning? [Other]		
3	su_b1	How often do your students use the following digital technologies in the classroom to support their learning? [Present something on the projector, such as a presentation (PowerPoint, Prezi, etc.).]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [To present something by projector (e.g., PowerPoint)](T)
3	su_b2	How often do your students use the following digital technologies in the classroom to support their learning? [Connect with others over the Internet.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [For Internet communication](T)
3	su_b3	How often do your students use the following digital technologies in the classroom to support their learning? [Present or publish their work online.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [For presentation / publication of student work](T)
3	su_b4	How often do your students use the following digital technologies in the classroom to support their learning? [Develop and design online content.]	(Petko, 2012) (I)	For what purpose do you use computers and the Internet in your classroom? [For development / design of online content](T)
3	su_b5	How often do your students use the following digital technologies in the classroom to support their learning? [Blog to present their work or content they have learned.]		
3	su_b6	How often do your students use the following digital technologies in the classroom to support their learning? [Connect with others on social media (e.g., Facebook, Twitter).]		
3	su_b7	How often do your students use the following digital technologies in the classroom to support their learning? [Collaborate with others on joint projects.]		
3	su_b8	How often do your students use the following digital technologies in the classroom to support their learning? [Share content they have created		

(continued)

RQ	ID	Survey Question (Student Use of Digital Technology)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
		with others on social media (e.g., Facebook, Twitter, Tumblr, Pinterest).]		
3	su_b9	How often do your students use the following digital technologies in the classroom to support their learning? [Other]		
1	su_c1	In my classes, students learn… [about the world outside of school.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes… [students learn something about the world outside of school.](T)
1	su_c2	In my classes, students learn… [that new knowledge is linked with student questions or experiences.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes … [learning new knowledge is linked to existing extracurricular experiences or questions from the students.](T)
1	su_c3	In my classes, students learn… [the importance of what they have learned for outside of school.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes … [students learn the importance of what they have learned for their out-of-school life.](T)
1	su_c4	In my classes, students learn… [that school-based knowledge does not always provide an answer.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes … [students learn that school-based knowledge does not always provide an answer.](T)
1	su_c6	In my classes, students learn… [that knowledge is influenced by cultural values and opinions.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes … [students learn that school-based knowledge is influenced by cultural values and opinions.](T)
1	su_c7	In my classes, students learn… [Other - Fill in Blank]		
1	su_d1	In my classes, students… [feel safe questioning what or how they are being taught.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes … [students are encouraged to question what they need to learn and how they are taught .](T)
1	su_d3	In my classes, students… [help me plan what they will learn.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes … [Students help me plan what they will learn .](T)
1	su_d4	In my classes, students… [help me decide how well they are learning.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes … [Students help me assess how well they learn .](T)
1	su_d5	In my classes, students… [help me decide which activities are appropriate.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes … [students help me decide which activities are best suited for them.](T)
1	su_d6	In my classes, students… [interact with each other in the classroom.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes… [students have opportunity to interact with each other in the classroom.](T)
1	su_d7	In my classes, students… [discuss how to solve tasks with each other.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes… [Students discuss with each other how they can solve the tasks.](T)

RQ	ID	Survey Question (Student Use of Digital Technology)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
1	su_d8	In my classes, students… [explain their ideas to other students.]	(Johnson & McClure, 2004; Petko, 2012) (I)	In my classes… [students explain their thoughts other students.](T)
1	su_e1	In recent years, my frequency of technology use in the classroom has… [ ]	(Petko, 2012) (I)	Has the frequency of your use of computers in the classroom changed in recent years?(T)

Table B3

B*ring Your Own Device Program Specifics*

	ID	Survey Question (Bring Your Own Device Program Specifics)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
1	by_a1	Please indicate your agreement level with the statements: BYOD is… [exciting.]		
1	by_a2	Please indicate your agreement level with the statements: BYOD is… [more trouble than it is worth.]		
1	by_b1	Please agree or disagree with the statements: With BYOD… [I like seeing my students discover what they can do with their devices.]		
1	by_b2	Please agree or disagree with the statements: With BYOD… [I like that my students have different devices.]		
1b	by_b3	Please agree or disagree with the statements: With BYOD… [our school provides appropriate support for BYOD in my classroom.]		
1	by_b4	Please agree or disagree with the statements: With BYOD… [I am effective with class management when students have their devices.]		
1, 3	by_b5	Please agree or disagree with the statements: With BYOD… [students behave more appropriately in class than without BYOD.]		
1, 3	by_b6	Please agree or disagree with the statements: With BYOD… [students can learn from each other how to use their devices effectively.]		
1	by_b7	Please agree or disagree with the statements: With BYOD… [teachers should know how to use each student device.]		
1, 3	by_b8	Please agree or disagree with the statements: With BYOD… [Students can learn to use their devices effectively through working on assignments.]		

	ID	Survey Question (Bring Your Own Device Program Specifics)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
1b	by_c1	Please select the features of BYOD program at your school. Students are… [encouraged to bring whatever they have.]		
1b	by_c2	Please select the features of BYOD program at your school. Students are… [encouraged to bring laptops or a more powerful computer.]		
1b	by_c3	Please select the features of BYOD program at your school. Students are… [encouraged to bring a tablet (iPad or similar) or more powerful device.]		
1b	by_c4	Please select the features of BYOD program at your school. Students are… [required to bring laptops or more powerful computer.]		
1b	by_c5	Please select the features of BYOD program at your school. Students are… [required to bring a tablet (iPad or equivalent) or more powerful device.]		
2	by_d1	Thinking about your students and the BYOD program, choose your best estimate for students who… [have a home Internet connection.]		
2	by_d2	Thinking about your students and the BYOD program, choose your best estimate for students who… [bring laptop-type computers.]		
2	by_d3	Thinking about your students and the BYOD program, choose your best estimate for students who… [bring tablets (iPads or similar).]		
2	by_d4	Thinking about your students and the BYOD program, choose your best estimate for students who… [bring smart phones.]		
2	by_d5	Thinking about your students and the BYOD program, choose your best estimate for students who… [bring other types of devices capable of accessing the Internet.]		
2	by_d6	Thinking about your students and the BYOD program, choose your best estimate for students who… [routinely have more than one device capable of accessing the Internet with them.]		
2	by_d7	Thinking about your students and the BYOD program, choose your best estimate for students who… [routinely do not bring at least one device with them.]		
2	by_e1	When a student does not have a device capable of accessing the Internet, how often does a student… [not have access to any device for the period]		
2	by_e2	When a student does not have a device capable of accessing the Internet, how often does a student… [work with someone who has a device.]		

(continued)

	ID	Survey Question (Bring Your Own Device Program Specifics)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
2	by_e3	When a student does not have a device capable of accessing the Internet, how often does a student… [borrow a device from another student.]		
2	by_e4	When a student does not have a device capable of accessing the Internet, how often does a student… [use a school-owned tablet (iPad or similar).]		
2	by_e5	When a student does not have a device capable of accessing the Internet, how often does a student… [use a school-owned laptop.]		
2	by_e6	When a student does not have a device capable of accessing the Internet, how often does a student… [use a school-owned desktop in the room.]		
2	by_e7	When a student does not have a device capable of accessing the Internet, how often does a student… [go to a computer lab or other room to use a computer or tablet.]		
2	by_e8	When a student does not have a device capable of accessing the Internet, how often does a student… [Other (comment)]		
2	by_e9	Thinking about your students and the devices they bring to class, how often does almost every student bring at least one device… [Additional comments about the types of devices your students bring to class.]		
2	by_f1	Thinking about your students and the devices they bring to class, how often does almost every student bring at least one device… [capable of accessing the Internet?]		
2	by_f2	Thinking about your students and the devices they bring to class, how often does almost every student bring at least one device… [that is the same size or larger than a tablet (iPad or equivalent)?]		
2, 3	by_g1	When your students do not know how to do a task, with their device, how often do the following happen: [The student does not learn to do the task.]		
3	by_g2	When your students do not know how to do a task, with their device, how often do the following happen: [The student searches the Internet for help.]		
3	by_g3	When your students do not know how to do a task, with their device, how often do the following happen: [You help the student.]		
3	by_g4	When your students do not know how to do a task, with their device, how often do the following happen: [The student independently seeks help from other students.]		
3	by_g5	When your students do not know how to do a task, with their device, how often do the following happen: [Other students offer to help the student.]		

(continued)

	ID	Survey Question (Bring Your Own Device Program Specifics)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
3	by_g6	When your students do not know how to do a task, with their device, how often do the following happen: [You ask for technical assistance from others not in the classroom.]		
3	by_g7	When your students do not know how to do a task, with their device, how often do the following happen: [Other]		
2	by_h1	Please agree or disagree with each statement. [BYOD programs can be implemented in such a way as to address equity among students.]		
2	by_h2	Please agree or disagree with each statement. [At our school, BYOD has been implemented in such a way as to address equity among students.]		
2	by_j1	Please provide information about whether or not… [student equity is addressed in your BYOD program and how it is addressed.]		
3	by_k1	Please provide information about whether or not… [the BYOD program in your school is effective for your students.]		
1	by_m1	Choose one location between each adjective pair to indicate how you feel. BYOD is… [suffocating <————————> fresh]	(Knezek et al., 2000; Shattuck et al., 2011) (I)	Choose one location between each adjective pair to indicate how you feel about computers. Computers are… [suffocating <————————> fresh]
1	by_m2	Choose one location between each adjective pair to indicate how you feel. BYOD is… [dull <————————> exciting]	(Knezek et al., 2000; Shattuck et al., 2011) (I)	Choose one location between each adjective pair to indicate how you feel about computers. Computers are… [dull <————————> exciting]
1	by_m3	Choose one location between each adjective pair to indicate how you feel. BYOD is… [unlikeable <————————> likeable]	(Knezek et al., 2000; Shattuck et al., 2011) (I)	Choose one location between each adjective pair to indicate how you feel about computers. Computers are… [unlikeable <————————> likeable]
1	by_m4	Choose one location between each adjective pair to indicate how you feel. BYOD is… [unhappy <————————> happy]	(Knezek et al., 2000; Shattuck et al., 2011) (I)	Choose one location between each adjective pair to indicate how you feel about computers. Computers are… [unhappy <————————> happy]
1b	by_n1	How long have any teachers in your school been allowing students to use their own devices in the classroom?		

(continued)

	ID	Survey Question (Bring Your Own Device Program Specifics)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
1b	by_p1	Is your school's or district's BYOD policy… [written?]		
1b	by_p2	Is your school's or district's BYOD policy… [available through the Internet for parents and students?]		
1b	by_q1	More information about your school's BYOD policy: [If you were to talk to prospective parents about your BYOD program, what would you tell them?]		

Table B4

Factors Supporting Technology Use

RQ	ID	Survey Question (Factors Supporting Technology Use)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
1b	sf_j1	When thinking about the digital technology infrastructure at your school, what is the availability of… [computers for teachers?]	(Petko, 2012) (I)	How do you assess the ICT infrastructure at their school / school? [Availability of computers for teachers / staff](T)
1b	sf_j2	When thinking about the digital technology infrastructure at your school, what is the availability of… [laptops or tablets (iPad or similar) or teachers?]		How do you assess the ICT infrastructure at their school / school? [Availability of computers for teachers / staff](T)
1b	sf_j3	When thinking about the digital technology infrastructure at your school, what is the availability of… [school-provided computers or tablets (iPad or similar) for students?]	(Petko, 2012) (I)	How do you assess the ICT infrastructure at their school / school? [Availability of computers for students](T)
1b	sf_j4	When thinking about the digital technology infrastructure at your school, what is the availability of… [good wireless Internet?]	(Petko, 2012) (I)	How do you assess the ICT infrastructure at their school / school? [Availability of Internet for teachers / staff](T)
1b	sf_j5	When thinking about the digital technology infrastructure at your school, what is the availability of… [fast Internet?]	(Petko, 2012) (I)	How do you assess the ICT infrastructure at their school / school? [Speed of the Internet connection](T)
1b	sf_j6	When thinking about the digital technology infrastructure at your school, what is the availability of… [basic display technology (e.g., digital projectors, interactive white boards?]	(Petko, 2012) (I)	How do you assess the ICT infrastructure at their school / school? [Availability of peripheral devices (eg printers , scanners, cameras , etc.)](T)
1b	sf_j7	When thinking about the digital technology infrastructure at your school, what is the availability of… [advanced display technologies (e.g., 3-D projectors or displays, interactive tables)?]		

(continued)

RQ	ID	Survey Question (Factors Supporting Technology Use)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
1b	sf_j8	When thinking about the digital technology infrastructure at your school, what is the availability of… [technical support?]	(Petko, 2012) (I)	How do you assess the ICT infrastructure at their school / school? [Availability of technical support](T)
1b	sf_k1	When thinking about the digital technology infrastructure at your school, what is the availability of… [instructional support for integrating digital technologies into classes?]	(Petko, 2012) (I)	How do you assess the ICT infrastructure at their school / school? [Availability of any instructional advice](T)
1b	sf_k2	When thinking about the support for digital technology at your school, what is the availability of… [Training sessions on how to use hardware and software?]	(Petko, 2012) (I)	What training and support services to computer and internet access are available at your school? [Technical Courses](T)
1b	sf_k3	When thinking about the support for digital technology at your school, what is the availability of… [Professional development sessions on how to integrate digital technologies into lessons?]	(Petko, 2012) (I)	What training and support services to computer and internet access are available at your school? [Courses on teaching](T)
1b	sf_k4	When thinking about the support for digital technology at your school, what is the availability of… [An academic support person able to come into a class to model use of digital technologies with students?]	(Petko, 2012) (I)	What training and support services to computer and internet access are available at your school? [Personal educational counseling](T)
1b	sf_k5	When thinking about the support for digital technology at your school, what is the availability of… [Online support (e.g., FAQ, school or district help documents online, online discussion groups or email lists)?]	(Petko, 2012) (I)	What training and support services to computer and internet access are available at your school? [Electronic consultation (email , FAQ)](T)
1b	sf_k6	When thinking about the support for digital technology at your school, what is the availability of… [informal guidance from colleagues?]	(Petko, 2012) (I)	What training and support services to computer and internet access are available at your school? [Collegial informal guidance](T)
1b	sf_m1	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Technology support]	(Ertmer et al., 2012) (R)	
1b	sf_m2	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Technology reliability]	(Ertmer et al., 2012) (R)	
1b	sf_m3	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Internet availability]		
1b	sf_m4	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Wireless Internet availability]		
1b	sf_m5	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Overall technology access]	(Ertmer et al., 2012) (R)	
1b	sf_m6	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [State standards]	(Ertmer et al., 2012) (R)	

(continued)

RQ	ID	Survey Question (Factors Supporting Technology Use)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
1b	sf_m7	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Standardized assessments]	(Ertmer et al., 2012) (R)	
1b, 2	sf_m8	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Overall funding]	(Ertmer et al., 2012) (R)	
1b	sf_q1	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Available time with students]	(Ertmer et al., 2012) (R)	
1b	sf_p1	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [The number of students who bring a device]		
1b	sf_p2	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Students have a variety of devices]		
1b	sf_l1	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [The culture of the subject you teach]	(Ertmer et al., 2012) (R)	
1b	sf_q2	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Time to plan BYOD implementation.]		
1b	sf_q3	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Time available to discuss BYOD issues with other teachers]		
1b	sf_n2	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Other teachers' attitudes and beliefs]	(Ertmer et al., 2012) (R)	
1b	sf_r1	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Your own knowledge and skills]	(Ertmer et al., 2012) (R)	
1b	sf_r2	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Your own attitudes and beliefs]	(Ertmer et al., 2012) (R)	
1b	sf_n3	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Student knowledge and skills]		
1b	sf_n4	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [School or district administration]	(Ertmer et al., 2012) (R)	

(continued)

RQ	ID	Survey Question (Factors Supporting Technology Use)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
1b	sf_n5	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Parents]	(Ertmer et al., 2012) (R)	
1b	sf_n6	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Community]	(Ertmer et al., 2012) (R)	
1b	sf_s1	Please agree or disagree with the following statement: [Our school has an appropriate written policy on the use of digital technology.]	(Petko, 2012) (I)	Your opinion on the use of computers in the classroom [At our school there is a detailed written policy on the use of ICT.](T)

Table B5

Demographics

RQ	ID	Survey Question (Demographics)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
	de_b1	Demographic information [School Type]		
	de_b2	Demographic information [School Setting]		
	de_b2a	Demographic information [Is your school in North America?]		
	de_c1	How many years have you been… [teaching in schools?]	(Petko, 2012) (I)	What year did you begin teaching in the school system(T)
	de_c2	How many years have you been… [using digital technologies professionally?]	(Petko, 2012) (I)	How many years have you already used computers for educational purposes(T)
	de_d1	What is your main teaching responsibility? [What school level do you mainly teach?]	(Petko, 2012) (I)	What grades do you mainly teach(T)
	de_e1	What subjects do you teach? [Elementary self-contained]		
	de_e2	What subjects do you teach? [Elementary - other]		
	de_e3	What subjects do you teach? [Computer Science or Computer media]	(Petko, 2012) (I)	What subjects do you teach? [ICT / Media Education / computer science](T)
	de_e5	What subjects do you teach? [English/Language Arts]	(Petko, 2012) (I)	What subjects do you teach? [English](T)
	de_e6	What subjects do you teach? [Other Language]	(Petko, 2012) (I)	What subjects do you teach? [French](T)
	de_e7	What subjects do you teach? [History or Social Studies]	(Petko, 2012) (I)	What subjects do you teach? [Geography](T)

(continued)

RQ	ID	Survey Question (Demographics)	Source - Instrument (I) or Reference (R)	Original question if applicable (T indicates translation).
	de_e8	What subjects do you teach? [Mathematics]	(Petko, 2012) (I)	What subjects do you teach? [Mathematics](T)
	de_e9	What subjects do you teach? [Performing Arts]	(Petko, 2012) (I)	What subjects do you teach? [Music](T)
	de_e10	What subjects do you teach? [PE]	(Petko, 2012) (I)	What subjects do you teach? [Physical Education](T)
	de_e11	What subjects do you teach? [Science]	(Petko, 2012) (I)	What subjects do you teach? [Natural history / science](T)
	de_e12	What subjects do you teach? [Visual Arts]	(Petko, 2012) (I)	What subjects do you teach? [Visual Arts](T)
	de_e13	What subjects do you teach? [Other (please List)]	(Petko, 2012) (I)	What subjects do you teach? [Other](T)

APPENDIX C

Interview Protocol

The following protocol was used for interviews. All participants were informed during scheduling that the interviews would be audio recorded in case that might influence their decision to participate. None declined to participate. They were also sent a copy of the informed consent for interviews as well as the prompts for the interview.

After participants expressed an interest in participating in an interview by completing the form that appeared after they completed the survey, the researcher emailed potential participants with a request to set up an interview. All emails had a standard signature line identifying the researcher with contact information.

Interview Request Email

Subject: Interview about your BYOD experiences

Dear Teacher,

Thank you for volunteering to participate in an interview about *Teacher Use and Perceptions of the Successes and Challenges of Bring Your Own Device (BYOD) Programs.* Sharing your expertise with BYOD really has the potential to help other teachers.

The purpose of this email is to schedule a time for the interview. After reading the informed consent (below), if you wish to participate in this research, please reply to this email with your time zone, and potential times and dates you may be available. I am normally available _____ but I can also accommodate your schedule. Because of the need to record the audio, we can connect with Skype or I can call you on your telephone anywhere in the world. At the completion of the survey, you will have the opportunity to select a charity for a small donation.

[Researcher's name.]

[Researchers contact information.]

Informed Consent

The following information is provided to help you decide whether you wish to participate in a research study. Please take your time to read the information below and feel free to ask any questions before agreeing to participate.

My name is Derrel Fincher, and I am a Doctoral student in the Learning Technologies program at Pepperdine University and the professor supervising my work is Dr. Margaret Riel. The title of my research study is *Teacher Use and Perceptions of the Successes and Challenges of Bring Your Own Device (BYOD) Programs* and is being done as partial fulfillment of the requirements for my Doctoral degree.

Purpose of Research Study. I am conducting this study to determine how schools and teachers implement a BYOD program and the issues, challenges, and benefits that teachers find when students bring their own device to use in the classroom. The goal is to understand successful, and not-so-successful practices in BYOD programs so that other teachers and schools considering a BYOD program will have better information. Your experiences working in a school with a Bring Your Own Device (BYOD)—sometimes known as a Bring Your Own Technology (BYOT)—program will help other schools and teachers as they develop their own BYOD programs.

Procedures. If you volunteer to participate in the interview portion in this research study, I will arrange a time to interview you via Skype, telephone, or other suitable method. The interview audio will be recorded for research purposes, but your name or other identifying information will not be part of the recording. The maximum time required for the interview is expected to be twenty-five minutes. The interview will include the interview prompts listed at the end of this message and a few questions about your professional background. I may ask additional questions to make sure I understand your responses.

Potential Risks. This research has minimal risks, primarily the loss of time during the interview.

Potential Benefit. Completing the interview may help you reflect on your practices and you will have the option of receiving a summary of teachers' perceptions of the benefits and challenges of programs like yours.

Voluntary/right to deny or withdraw from participation. Your participation in the research study is completely voluntary, and you have the right to stop at any time, or skip any questions, with no negative consequences to you.

Confidentiality. Data obtained for this research study, including your responses in the interview, will be kept confidential. The confidentiality of my records will be maintained in accordance with applicable state and federal laws. The audio will be recorded into an encrypted area of my hard drive, and only I and a transcriptionist will have access to the audio. I will delete any potential identifying information from the recordings before sending them for transcription. Any contact information, should you choose to provide it to receive results of the study, will be collected separately and kept separately from the interview results. Research records will be kept for a minimum of three years then destroyed.

The results of this research study will be summarized as a whole, so as no persons will be able to identify you.

Contact information for questions or concerns. If you have further questions regarding this research, you may contact me, the primary investigator, Derrel Fincher at: derrel.fincher@pepperdine.edu, or my faculty supervisor, Dr. Margaret Riel at margaret.riel@pepperdine.edu, . If you have questions about your rights as a research participant, you may contact Dr. Thema Bryant-Davis, Chairperson of the GPS IRB at Pepperdine University at gpsirb@pepperdine.edu, 310-568-5753.

Consent. Before starting the recording, I will verify that you have received this informed consent document and give you an opportunity to ask questions. If you would like documentation of your participation in this research, you may print a copy of this form.

Interview Prompts for Interview Request Email

1. Can you tell me of an experience or experiences where you thought having BYOD in your classroom was really effective?
2. What are some of your favorite digital tools or programs you use with your students when they use BYOD?
3. Can you tell me of an experience or experiences where you thought having BYOD in your classroom was ineffective?
4. What happens if you have a student who is unable to bring a device?
5. What challenges have you had or continue to have while trying to implement BYOD?
6. Can you tell me about any relationship between BYOD in your school and equity among students?
7. How do your students learn to use their devices effectively for learning?
8. Is there anything else you would like to tell me about BYOD or using digital technologies in your school that we may not have covered?

Interview Script

Interviewer: Thank you for agreeing to participate in this interview. I am really looking forward to hearing about your experiences with BYOD. I just want to verify, did you receive the interview prompts and the informed consent?

If the answer is yes, proceed. If the answer is no, help them locate the information by telling them the time and date it was sent. If they still cannot find it, resend the information while they are connected, then ask if they have time to read the informed consent and questions now, or if they would like to reschedule.

Interviewer: Let me just touch on a few items in the informed consent that you received. Your participation is voluntary and you may end the interview at any time. Anything you tell me is

confidential and no responses will be linked to you or to your school or school district. The study poses minimal risk to participants, which are loss of time, possible boredom, or fatigue. Do you have any questions about what participation in this research study involves? Would you like to participate in this research study?

If yes, continue. If no, clarify the issues. If the participant wishes to stop, thank him or her for their time and politely end the conversation.

Interviewer: This interview will be recorded. For anonymity, while the recording is on, I will not use your name or your school. If you or I inadvertently slip, I will erase that identifying information from the recording before transcription. May I start recording?

If yes, begin the recorder and continue. If no, clarify their concerns. If they wish to end the interview, thank them for their time.

Interviewer begins recording.

Interviewer. I have turned on the recorder and we have already covered informed consent, is that correct?

If yes, continue. If no, clarify their concerns. If they wish to end the interview, thank them for their time.

The interview begins and the interviewer first asks the following demographic questions that correspond with the same questions on the survey, with no more than a minute taken to ask the questions:

- What type of school do you teach in: public, independent - secular, independent - religious, public charter, or other?
- What is your school's location: urban, suburban, town, rural, remote, non-North America, or other?

- What school level do you mainly teach: pre-school, primary / elementary, middle school / junior high, high school, or vocational / career education?
- How many years have you been teaching in schools?
- How many years have you been using digital technologies professionally?

Following those questions the questions below are asked in the order shown. The interviewer may provide additional prompts as needed in order to clarify answers or explore some aspects of the participant's BYOD experiences. If the participant accidentally provides identifying information during the interview, the interviewer records the time so as to delete the information from the recording later.

1. Can you tell me of an experience or experiences where you thought having BYOD in your classroom was really effective?
2. What are some of your favorite digital tools or programs you use with your students when they use BYOD?
3. Can you tell me of an experience or experiences where you thought having BYOD in your classroom was ineffective?
4. What happens if you have a student who is unable to bring a device?
5. What challenges have you had or continue to have while trying to implement BYOD?
6. Can you tell me about any relationship between BYOD in your school and equity among students?
7. How do your students learn to use their devices effectively for learning?
8. Is there anything else you would like to tell me about BYOD or using digital technologies in your school that we may not have covered?

The interviewer then proceeds to end the interview.

Interviewer: Thank you very much for your insights and expertise. After transcription, may I email the interview to you for you to proofread and correct? Your participation in this researcher is

invaluable and will help others. As mentioned in the initial contact, I will donate $10 for a completed interview to either Save the Children or Books for Africa. Which charity would you prefer?

The interviewer stops recording and politely ends the interview.

Post Interview Actions

At the conclusion of the interview, the interviewer renamed the audio of the interview with a project name, four digit year recorded, two digit month recorded, and a random, non-sequential two digit hexadecimal number to make each recording name unique, e.g. *BYODInterview_201403_5A*. If the participant provided identifying information in the interview, the interviewer edited the audio file to delete the identifying information, either by overwriting with silence or with an appropriate replacement, e.g., replace *John Smith* with *colleague.* Such changes are delimited by brackets in the transcripts.

The request for the participant to proof the transcript was sent again after seven days if the participant did not return the email the first time. After two attempts with no response, the transcript was considered correct. Only four participants had minor corrections.

Proofing Message to Participant

Subject: Please proof your BYOD interview transcript

Dear [Interview Participant],

Thank you for talking with me for the BYOD research. The transcript of the interview is attached. Can you please proofread it and return it to me with any corrections or expansions? If you have any questions, please contact me. I look forward to your response.

[Researcher's name.]

[Researchers contact information.]

APPENDIX D

Recruiting Messages

This appendix contains the invitations and other messages used to recruit participants. There were several types of recruiting messages: a direct email to teachers who had a high probability of teaching in a BYOD classroom or school, a direct email to other educators who were not classroom teachers but could forward the message to classroom teachers, a message posted in public forums asking for participation, tweets, and the content on a website. All emails were sent from the researcher's university email address.

Classroom Teacher Invitation

Subject: Request for your BYOD expertise

Dear Teacher, [Use name if known.]

I am conducting a study to understand how teachers implement a Bring Your Own Device (BYOD) program in their classroom. The title of my research study is *Teacher Use and Perceptions of the Successes and Challenges of Bring Your Own Device (BYOD) Programs* and is being done as partial requirement for my Doctoral degree. Your expertise in BYOD is valuable. It can help other schools and teachers as they plan a BYOD program or work to improve their current program.

In return for your participation, I will provide you a summary of the results after the analysis is completed. And, as a way to support a worthy cause, I will make a small contribution to your choice of *Save the Children* or *Books for Africa* for your completed survey. Both charities help children and are top-ranked in the *Charity Navigator*. [Italicized content is hyperlinked to the website for the organization.]

Click here to go the survey. [The previous text is hyperlinked to the URL of the survey.]

If you can, please forward this email to any teachers you know who are doing BYOD, and please feel free to contact me with questions or comments.

Best regards,

[Researcher's name.]

[Researchers contact information.]

Educator Invitation

Subject: Request for help with BYOD research

Dear Educator, [Use name if known.]

I am conducting a study to understand how teachers implement a Bring Your Own Device (BYOD) program in their classroom. The title of my research study is *Teacher Use and Perceptions of the Successes and Challenges of Bring Your Own Device (BYOD) Programs* and is being done as partial requirement for my Doctoral degree. I need your help asking teachers to participate. In return, I will send you a summary of the results when the research and analysis is completed. As a way to support a worthy cause, I will make a small contribution to *Save the Children* or *Books for Africa* as selected by the participant for each completed survey. Both charities help children and are top-ranked in the *Charity Navigator*. [Italicized content is hyperlinked to the website for the organization.] Below is a sample email you may forward as is or edit before sending to teachers.

[Researcher's name] is researching how teachers' integrate BYOD in their classes, and whether or not they think it helps student learning. Please consider participating. You may find more information and the survey link on http://byodresearch.net, including a link for contacting him if you need more information. I also have asked for a summary of the research results to be sent to us after the research is completed. Thank you for your help!

If you would like a copy of the results of the research after the analysis is completed, please click here. [The previous text is hyperlinked to the URL of the survey.]

Best regards,

[Researcher's name.]

[Researchers contact information.]

Public Forum Invitation

Subject: Please participate in BYOD research

I am conducting a study to understand how teachers implement a Bring Your Own Device (BYOD) program in their classroom. The title of my research study is *Teacher Use and Perceptions of the Successes and Challenges of Bring Your Own Device (BYOD) Programs* and is being done as partial requirement for my Doctoral degree. If you are a teacher in a BYOD program, please consider participating by completing a survey. As a way to support a worthy cause, I will make a small contribution to *Save the Children* or *Books for Africa* as selected by the participant for each completed survey. Both charities help children and are top-ranked in the *Charity Navigator*. You will also have an opportunity to request a summary of the results to be sent to you after the research and analysis is completed. [Italicized content is hyperlinked to the website for the organization.]

Click here to go the survey. [The previous text is hyperlinked to the URL of the page for information.]

Please share the survey link, or you may share the collaboration link, [URL of website].

Please feel free to contact me with any questions.

[Researcher's name.]

[Researchers contact information.]

BYOD Research Website

Teacher Use and Perceptions of the Successes and Challenges of Bring Your Own Device (BYOD) Programs

Thank you for visiting this website.

I am conducting this study to determine how schools and teachers implement a BYOD program and the issues, challenges, and benefits that teachers find when students bring their own device to use

in the classroom. The goal is to understand successful, and not-so-successful practices in BYOD programs so that other teachers and schools considering a BYOD program will have better information. Your experiences working in a school with a Bring Your Own Device (BYOD)—sometimes known as a Bring Your Own Technology (BYOT)—program will help other schools and teachers as they develop their own BYOD programs. Participating in this study involves completing a 20-25 minute survey where the questions will ask you about your professional use of digital technologies, how you use digital technologies with your students, how you accommodate student-owned devices in your classroom and how your school or districts provides support for your use of digital technologies and student-owned devices. You also may volunteer for an interview after completing the survey.

In return for your participation, I will provide you a summary of the results after the analysis is completed. And, as a way to support a worthy cause, I will personally make a small contribution to your choice of *Save the Children* or *Books for Africa* for your completed survey. Both charities help children and are top-ranked in the *Charity Navigator*. [Italicized content is hyperlinked to the website for the organization.]

Click here to go the survey. [The previous text is hyperlinked to the URL of the survey.]

Please encourage other teachers to participate by sending them the link to this website.

If you have any questions, please email me. [The last is hyperlinked to the email address.]

[Additional contact information added here.]

Amount raised to date for *Save the Children:* [Amount will be updated periodically. Initial value will be $100.]

Amount raised to date for *Books for Africa:* [Amount will be update periodically. Initial value will be $100.]

Tweets

Each item below is a separate tweet for posting on the Twitter microblogging platform. The tweets will have hashtags added to increase the likelihood that teachers and administrators participating in BYOD programs will see them. Tweets will be made at various times during the data collection phase, and if attached to a retweet, they may be shortened so that it all fits within the 140 character limit of Twitter. Example tweets are below.

1. Do you #BYOD? Can you share your expertise for research? Find out more at [URL of website.]
2. Do you know somebody who is a #BYOD wiz? Even you? Ask them to participate in #BYOD Research. [URL of website.]
3. #BYOD #BYOT #BYOL It doesn't matter what it's called if you're the expert. Participate in research. [URL of Website.]
4. Do you #BYOD #BYOT #BYOL Help raise funds for #SavetheChildren by participating in #BYOD research. [URL of Website.]
5. Do you #BYOD #BYOT #BYOL? Raise funds for #BooskforAfrica by participating in research. [URL of Website.]
6. Teachers have helped raise [dollar amount] for #SavetheChildren by participating in #BYOD research [URL of Website.] You can help.
7. Teachers have helped raise [dollar amount] for #BooskforAfrica by participating in #BYOD research [URL of Website.] You can help.
8. #BYOD #BYOT #BYOL [URL of Website].

Completion Message

Subject: BYOD research wrap-up

Dear Educator,

Thank you for participating in my research on BYOD. You may download a summary of the research and see the contributions made to *Save the Children* and *Books for Africa* from [URL of link].

Your participation can help schools and teachers as they implement BYOD programs, and the donations to charity made a difference in the lives of children. Again, thank you.

Best regards,

[Researcher's name.]

[Researchers contact information.]

APPENDIX E

Institutional Review Board Approval

The letter from the Pepperdine Institutional Review Board approving the research is on the following two pages.

PEPPERDINE UNIVERSITY

Graduate & Professional Schools Institutional Review Board

November 21, 2014

Derrel Fincher

Protocol #: E0914D03
Project Title: Teacher use and perceptions of the successes and challenges of bring your own device (BYOD) programs

Dear Mr. Fincher:

Thank you for submitting your application, *Teacher use and perceptions of the successes and challenges of bring your own device (BYOD) programs,* for exempt review to Pepperdine University's Graduate and Professional Schools Institutional Review Board (GPS IRB). The IRB appreciates the work you and your faculty advisor, Dr. Riel, have done on the proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations (45 CFR 46 - http://www.nihtraining.com/ohsrsite/guidelines/45cfr46.html) that govern the protections of human subjects. Specifically, section 45 CFR 46.101(b) (2) states:

> (b) Unless otherwise required by Department or Agency heads, research activities in which the only involvement of human subjects will be in one or more of the following categories are exempt from this policy:
>
> **Category (2) of 45 CFR 46.101**, research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: a) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and b) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

In addition, your application to waive documentation of informed consent has been **approved**.

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

A goal of the IRB is to prevent negative occurrences during any research study. However, despite our best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the GPS IRB as soon as possible. We will ask for a complete explanation of the event and your response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the GPS IRB and the appropriate form to be used to report this information can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* (see link to "policy material" at http://www.pepperdine.edu/irb/graduate/).

Please refer to the protocol number denoted above in all further communication or correspondence related to this approval. Should you have additional questions, please contact Kevin Collins, Manager of the Institutional Review Board (IRB) at gpsirb@peppderdine.edu. On behalf of the GPS IRB, I wish you success in this scholarly pursuit.

Sincerely,

Thema Bryant-Davis, Ph.D.
Chair, Graduate and Professional Schools IRB

cc: Dr. Lee Kats, Vice Provost for Research and Strategic Initiatives
Mr. Brett Leach, Compliance Attorney
Dr. Margaret Riel, Faculty Advisor

APPENDIX F

Online Survey Analysis Cross Reference

This appendix presents a cross reference between questions in the survey, factors constructed by combining the results of several questions, and the notation used in Chapter 4. The information is shown in the same order as the survey questions are presented on the survey, with the research question mapping shown in the first column and the identification codes mapping shown in the first column. The first two characters of the identification code indicate the section that the question is in. The mappings are:

- TK: Teacher Knowledge and Use of Digital Technology (Table E1)
- SU: Student Use of Digital Technology (Table E2)
- BY: Bring Your Own Device Program Specifics (Table E3)
- SF: Factors Supporting Technology Use (Table E4)
- DE: Demographics (Table E5)

Lower case codes, e.g, *su_e1* represent items on the survey. Upper case codes, e.g., *TKE*, represent summative factors created from items on the survey. The value for the factors is the mean of the response items on the survey assigned to that factor. The information presented in the table is the research question that the survey question is intended to address; the survey question as used in the survey, mapping to the factor, and the response options. Many of the survey questions have a common prompt followed by a specific question. The common prompt is first and the specific question follows in brackets, e.g., “Please rate your ability to use digital technology in the classroom: [Use computers and office software.]” Response options are only shown once for each factor.

Most of the survey items are not reported individually, but are instead grouped with similar items as a summative factor. The individual items composing each summative factor can be found by using the name given in the paper, locate that in the short reference column of the summative factors,

then find the individual questions. Cronbach's alpha and number of survey items are only shown for results presented in the survey.

Summative Factors – Teacher Knowledge and Use of Digital Technology (Table E6)

Summative Factors – Student Use of Digital Technology (Table E7)

Summative Factors – Bring Your Own Device Program Specifics (Table E8)

Summative Factors – Factors Supporting Technology Use (Table E9)

Summative factors – Demographics (Table E10)

Research Questions

The research questions, indicated by RQ in the first column are numbered below. While some of the survey questions were developed to address the bulleted sub-questions for research question 1, they do not have a separate notation and are still indicated as being part of survey question 1.

1. How is teacher incorporation of student devices in instruction related to their own beliefs and practices around the use of technology professionally and for instruction?
    - How are their practices affected by the school support for technology?
    - How are their practices influenced by the school implementation of a BYOD program?
2. To what extent do teachers perceive that BYOD programs provide equitable access for all students?
3. To what extent do teachers perceive that students are successful in using their own technology for learning in a BYOD classroom?

Table E1

Teacher Knowledge and Use of Digital Technology

RQ	ID	Survey Question (Teacher Knowledge and Use of Digital Technology)	Factor	Response Options
1	tk_a1	Please rate your ability to use digital technology in the classroom: [Use computers and office software.]	TKA	No Knowledge, Limited Knowledge, Medium Knowledge, Good Knowledge, Very Good Knowledge
1	tk_a2	Please rate your ability to use digital technology in the classroom: [Perform Internet research.]	TKA	
1	tk_a3	Please rate your ability to use digital technology in the classroom: [Create slide shows.]	TKA	
1	tk_a4	Please rate your ability to use digital technology in the classroom: [Create online units on a learning platform (e.g., Moodle, Edmodo, Canvas, Blackboard).]	TKA	
1	tk_a5	Please rate your ability to use digital technology in the classroom: [Discuss with students issues emerging from digital technology (e.g., data protection, copyright, personal security or inappropriate content).]	TKA	
1	tk_a6	Please rate your ability to use digital technology in the classroom: [Your overall knowledge to make meaningful use of digital technologies for teaching.]	TKA	
1	tk_b1	Please rate your knowledge in helping students do the following: [Create their own presentations with graphics and video]	TKB	No Knowledge, Limited Knowledge, Medium Knowledge, Good Knowledge, Very Good Knowledge
1	tk_b2	Please rate your knowledge in helping students do the following: [Find and use appropriate and credible Internet resources and databases.]	TKB	
1	tk_b3	Please rate your knowledge in helping students do the following: [Create simple digital documents with texts and images.]	TKB	
1	tk_b4	Please rate your knowledge in helping students do the following: [Create interactive multimedia products.]	TKB	
1	tk_b5	Please rate your knowledge in helping students do the following: [Communicate appropriately over the Internet through multiple means (e.g., via email, forum, blogging, instant messaging).]	TKB	
1	tk_b6	Please rate your knowledge in helping students do the following: [Use learning software (e.g., vocabulary programs, scientific simulations).]	TKB	
1	tk_c1	Please indicate your level of agreement or disagreement with each statement. [I know how to use digital technologies to enhance students' learning.]	TKC	Strongly Disagree, Disagree, Neither Agree Nor Disagree, Agree, Strongly Agree
1	tk_c2	Please indicate your level of agreement or disagreement with each statement. [My unit planning includes how I will integrate digital technologies.]	TKC	

(continued)

RQ	ID	Survey Question (Teacher Knowledge and Use of Digital Technology)	Factor	Response Options
1	tk_c3	Please indicate your level of agreement or disagreement with each statement. [I routinely embed digital technologies into student activities and projects.]	TKC	
1	tk_c4	Please indicate your level of agreement or disagreement with each statement. [I discuss the use of digital media with my teaching colleagues at school.]	TKC	
1a	tk_d1	In your judgment, how committed are the following people to the use of digital technology and the Internet for digital learning in their school(s)? [District administrators]	TKD	Not at All, Little, Somewhat, Strongly, Very Strongly, N/A
1a	tk_d2	In your judgment, how committed are the following people to the use of digital technology and the Internet for digital learning in their school(s)? [School administrator(s)]	TKD	
1a	tk_d3	In your judgment, how committed are the following people to the use of digital technology and the Internet for digital learning in their school(s)? [School Board]	TKD	
1a	tk_d4	In your judgment, how committed are the following people to the use of digital technology and the Internet for digital learning in their school(s)? [Technology Directors]	TKD	
1a	tk_d5	In your judgment, how committed are the following people to the use of digital technology and the Internet for digital learning in their school(s)? [Other]	TKD	
1	tk_e1	How often do you… [use a computer or the Internet in lesson preparation?]	TKE	Never, Yearly, Monthly, Weekly, Daily
1	tk_e2	How often do you… [use a computer for professional, organizational and administrative purposes?]	TKE	
1	tk_e3	How often do you… [use the Internet in instruction?]	TKE	
1	tk_e4	How often do you… [have your students use their own devices in the classroom?]	TKE	
1	tk_e5	How often do you… [have the students in your classroom work on the Internet?]	TKE	
1	tk_e6	How often do you… [give homework that needs to be done using digital technologies?]	TKE	
1	tk_e7	How often do you… [work with your students on an Internet Learning platform (e.g., Moodle, Edmodo, Canvas, Blackboard)?]	TKE	
1	tk_e8	How often do you… [work with your students on other Internet platforms (e.g., blogs, social networks, wikis)?]	TKE	
1	tk_e9	How often do you… [raise awareness in your students of potential pitfalls or hazards on the Internet?]	TKE	
1	tk_e10	How often do you… [help your students understand the digital media landscape?]	TKE	

Table E2

Student Use of Digital Technology

RQ	ID	Survey Question (Student Use of Digital Technology)	Factor	Response Options
3	su_a1	How often do your students use the following digital technologies in the classroom to support their learning? [View videos.]	SUA	Never, Yearly, Monthly, Weekly, Daily
3	su_a2	How often do your students use the following digital technologies in the classroom to support their learning? [Use educational software or tutorials.]	SUA	
3	su_a3	How often do your students use the following digital technologies in the classroom to support their learning? [Do word processing/writing.]	SUA	
3	su_a4	How often do your students use the following digital technologies in the classroom to support their learning? [Create spreadsheets and databases.]	SUA	
3	su_a5	How often do your students use the following digital technologies in the classroom to support their learning? [Play educational games or simulations.]	SUA	
3	su_a6	How often do your students use the following digital technologies in the classroom to support their learning? [Use drawing and graphics programs.]	SUA	
3	su_a7	How often do your students use the following digital technologies in the classroom to support their learning? [Program or write code.]	SUA	
3	su_a8	How often do your students use the following digital technologies in the classroom to support their learning? [Practice keyboarding.]	SUA	
3	su_a9	How often do your students use the following digital technologies in the classroom to support their learning? [Evaluate and cite Internet resources.]	SUA	
3	su_a10	How often do your students use the following digital technologies in the classroom to support their learning? [Other]	SUA	
3	su_b1	How often do your students use the following digital technologies in the classroom to support their learning? [Present something on the projector, such as a presentation (PowerPoint, Prezi, etc.).]	SUB	Never, Yearly, Monthly, Weekly, Daily
3	su_b2	How often do your students use the following digital technologies in the classroom to support their learning? [Connect with others over the Internet.]	SUB	
3	su_b3	How often do your students use the following digital technologies in the classroom to support their learning? [Present or publish their work online.]	SUB	
3	su_b4	How often do your students use the following digital technologies in the classroom to support their learning? [Develop and design online content.]	SUB	

(continued)

RQ	ID	Survey Question (Student Use of Digital Technology)	Factor	Response Options
3	su_b5	How often do your students use the following digital technologies in the classroom to support their learning? [Blog to present their work or content they have learned.]	SUB	
3	su_b6	How often do your students use the following digital technologies in the classroom to support their learning? [Connect with others on social media (e.g., Facebook, Twitter).]	SUB	
3	su_b7	How often do your students use the following digital technologies in the classroom to support their learning? [Collaborate with others on joint projects.]	SUB	
3	su_b8	How often do your students use the following digital technologies in the classroom to support their learning? [Share content they have created with others on social media (e.g., Facebook, Twitter, Tumblr, Pinterest).]	SUB	
3	su_b9	How often do your students use the following digital technologies in the classroom to support their learning? [Other]	SUB	
1	su_c1	In my classes, students learn… [about the world outside of school.]	SUC	Almost Never, Rarely, Sometimes, Often, Almost Always
1	su_c2	In my classes, students learn… [that new knowledge is linked with student questions or experiences.]	SUC	
1	su_c3	In my classes, students learn… [the importance of what they have learned for outside of school.]	SUC	
1	su_c4	In my classes, students learn… [that school-based knowledge does not always provide an answer.]	SUC	
1	su_c6	In my classes, students learn… [that knowledge is influenced by cultural values and opinions.]	SUC	
1	su_c7	In my classes, students learn… [Other - Fill in Blank]	SUC	
1	su_d1	In my classes, students… [feel safe questioning what or how they are being taught.]	SUD	Almost Never, Rarely, Sometimes, Often, Almost Always
1	su_d3	In my classes, students… [help me plan what they will learn.]	SUD	
1	su_d4	In my classes, students… [help me decide how well they are learning.]	SUD	
1	su_d5	In my classes, students… [help me decide which activities are appropriate.]	SUD	
1	su_d6	In my classes, students… [interact with each other in the classroom.]	SUD	
1	su_d7	In my classes, students… [discuss how to solve tasks with each other.]	SUD	
1	su_d8	In my classes, students… [explain their ideas to other students.]	SUD	
1	su_e1	In recent years, my frequency of technology use in the classroom has… [ ]	SUE	Decreased Significantly, Decreased Slightly, Remained About The Same, Increased Slightly, Increased Significantly

Table E3

Bring Your Own Device Program Specifics

RQ	ID	Survey Question (Bring Your Own Device Program Specifics)	Factor	Response Options
1	by_a1	Please indicate your agreement level with the statements: BYOD is… [exciting.]	BYA	Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree
1	by_a2	Please indicate your agreement level with the statements: BYOD is… [more trouble than it is worth.]	BYA	
1	by_b1	Please agree or disagree with the statements: With BYOD… [I like seeing my students discover what they can do with their devices.]	BYB	Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree
1	by_b2	Please agree or disagree with the statements: With BYOD… [I like that my students have different devices.]	BYB	
1b	by_b3	Please agree or disagree with the statements: With BYOD… [our school provides appropriate support for BYOD in my classroom.]	BYB	
1	by_b4	Please agree or disagree with the statements: With BYOD… [I am effective with class management when students have their devices.]	BYB	
1, 3	by_b5	Please agree or disagree with the statements: With BYOD… [students behave more appropriately in class than without BYOD.]	BYB	
1, 3	by_b6	Please agree or disagree with the statements: With BYOD… [students can learn from each other how to use their devices effectively.]	BYB	
1	by_b7	Please agree or disagree with the statements: With BYOD… [teachers should know how to use each student device.]	BYB	
1, 3	by_b8	Please agree or disagree with the statements: With BYOD… [Students can learn to use their devices effectively through working on assignments.]	BYB	
1b	by_c1	Please select the features of BYOD program at your school. Students are… [encouraged to bring whatever they have.]	BYC	Checkbox
1b	by_c2	Please select the features of BYOD program at your school. Students are… [encouraged to bring laptops or a more powerful computer.]	BYC	
1b	by_c3	Please select the features of BYOD program at your school. Students are… [encouraged to bring a tablet (iPad or similar) or more powerful device.]	BYC	
1b	by_c4	Please select the features of BYOD program at your school. Students are… [required to bring laptops or more powerful computer.]	BYC	

(continued)

RQ	ID	Survey Question (Bring Your Own Device Program Specifics)	Factor	Response Options
1b	by_c5	Please select the features of BYOD program at your school. Students are… [required to bring a tablet (iPad or equivalent) or more powerful device.]	BYC	
2	by_d1	Thinking about your students and the BYOD program, choose your best estimate for students who… [have a home Internet connection.]	BYD	None or almost none, Less than 1/3, Between 1/3 and 2/3, More than 2/3, Almost all or all, Don't Know
2	by_d2	Thinking about your students and the BYOD program, choose your best estimate for students who… [bring laptop-type computers.]	BYD	
2	by_d3	Thinking about your students and the BYOD program, choose your best estimate for students who… [bring tablets (iPads or similar).]	BYD	
2	by_d4	Thinking about your students and the BYOD program, choose your best estimate for students who… [bring smart phones.]	BYD	
2	by_d5	Thinking about your students and the BYOD program, choose your best estimate for students who… [bring other types of devices capable of accessing the Internet.]	BYD	
2	by_d6	Thinking about your students and the BYOD program, choose your best estimate for students who… [routinely have more than one device capable of accessing the Internet with them.]	BYD	
2	by_d7	Thinking about your students and the BYOD program, choose your best estimate for students who… [routinely do not bring at least one device with them.]	BYD	
2	by_e1	When a student does not have a device capable of accessing the Internet, how often does a student… [not have access to any device for the period]	BYE	Never, Rarely, Sometimes, Often, Very Often or Always
2	by_e2	When a student does not have a device capable of accessing the Internet, how often does a student… [work with someone who has a device.]	BYE	
2	by_e3	When a student does not have a device capable of accessing the Internet, how often does a student… [borrow a device from another student.]	BYE	
2	by_e4	When a student does not have a device capable of accessing the Internet, how often does a student… [use a school-owned tablet (iPad or similar).]	BYE	
2	by_e5	When a student does not have a device capable of accessing the Internet, how often does a student… [use a school-owned laptop.]	BYE	
2	by_e6	When a student does not have a device capable of accessing the Internet, how often does a student… [use a school-owned desktop in the room.]	BYE	
2	by_e7	When a student does not have a device capable of accessing the Internet, how often does a student…	BYE	

(continued)

RQ	ID	Survey Question (Bring Your Own Device Program Specifics)	Factor	Response Options
		[go to a computer lab or other room to use a computer or tablet.]		
2	by_e8	When a student does not have a device capable of accessing the Internet, how often does a student… [Other (comment)]	BYE	
2	by_e9	Thinking about your students and the devices they bring to class, how often does almost every student bring at least one device… [Additional comments about the types of devices your students bring to class.]	BYE	Open Response
2	by_f1	Thinking about your students and the devices they bring to class, how often does almost every student bring at least one device… [capable of accessing the Internet?]	BYF	Never, Rarely, Sometimes, Often, Very Often or Always
2	by_f2	Thinking about your students and the devices they bring to class, how often does almost every student bring at least one device… [that is the same size or larger than a tablet (iPad or equivalent)?]	BYF	
2, 3	by_g1	When your students do not know how to do a task, with their device, how often do the following happen: [The student does not learn to do the task.]	BYG	Never, Rarely, Sometimes, Often, Very Often or Always
3	by_g2	When your students do not know how to do a task, with their device, how often do the following happen: [The student searches the Internet for help.]	BYG	
3	by_g3	When your students do not know how to do a task, with their device, how often do the following happen: [You help the student.]	BYG	
3	by_g4	When your students do not know how to do a task, with their device, how often do the following happen: [The student independently seeks help from other students.]	BYG	
3	by_g5	When your students do not know how to do a task, with their device, how often do the following happen: [Other students offer to help the student.]	BYG	
3	by_g6	When your students do not know how to do a task, with their device, how often do the following happen: [You ask for technical assistance from others not in the classroom.]	BYG	
3	by_g7	When your students do not know how to do a task, with their device, how often do the following happen: [Other]	BYG	
2	by_h1	Please agree or disagree with each statement. [BYOD programs can be implemented in such a way as to address equity among students.]	BYH	Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree

(continued)

RQ	ID	Survey Question (Bring Your Own Device Program Specifics)	Factor	Response Options
2	by_h2	Please agree or disagree with each statement. [At our school, BYOD has been implemented in such a way as to address equity among students.]	BYH	
2	by_j1	Please provide information about whether or not… [student equity is addressed in your BYOD program and how it is addressed.]	BYJ	Open Response
3	by_k1	Please provide information about whether or not… [the BYOD program in your school is effective for your students.]	BYK	Open Response
1	by_m1	Choose one location between each adjective pair to indicate how you feel. BYOD is… [suffocating <———————> fresh]	BYM	A set of semantic differential questions where the options were mapped on a scale that essentially ranged from a very low or negative perception to a very high or very positive perception
1	by_m2	Choose one location between each adjective pair to indicate how you feel. BYOD is… [dull <———————> exciting]	BYM	
1	by_m3	Choose one location between each adjective pair to indicate how you feel. BYOD is… [unlikeable <———————> likeable]	BYM	
1	by_m4	Choose one location between each adjective pair to indicate how you feel. BYOD is… [unhappy <———————> happy]	BYM	
1b	by_n1	How long have any teachers in your school been allowing students to use their own devices in the classroom?	BYN	Started this year, 1 year, 2 years, 3 years, 4 or more years
1b	by_p1	Is your school's or district's BYOD policy… [written?]	BYP	no-yes
1b	by_p2	Is your school's or district's BYOD policy… [available through the Internet for parents and students?]	BYP	no-yes
1b	by_q1	More information about your school's BYOD policy: [If you were to talk to prospective parents about your BYOD program, what would you tell them?]	BYQ	Open Response

Table E4

Factors Supporting Technology Use

RQ	ID*	Survey Question (Factors Supporting Technology Use)	Factor	Response Options
1b	sf_j1	When thinking about the digital technology infrastructure at your school, what is the availability of… [computers for teachers?]	SFJ	Very Poor, Poor, Fair, Good, Very Good
1b	sf_j2	When thinking about the digital technology infrastructure at your school, what is the availability of… [laptops or tablets (iPad or similar) or teachers?]	SFJ	

(continued)

RQ	ID*	Survey Question (Factors Supporting Technology Use)	Factor	Response Options
1b	sf_j3	When thinking about the digital technology infrastructure at your school, what is the availability of… [school-provided computers or tablets (iPad or similar) for students?]	SFJ	
1b	sf_j4	When thinking about the digital technology infrastructure at your school, what is the availability of… [good wireless Internet?]	SFJ	
1b	sf_j5	When thinking about the digital technology infrastructure at your school, what is the availability of… [fast Internet?]	SFJ	
1b	sf_j6	When thinking about the digital technology infrastructure at your school, what is the availability of… [basic display technology (e.g., digital projectors, interactive white boards?]	SFJ	
1b	sf_j7	When thinking about the digital technology infrastructure at your school, what is the availability of… [advanced display technologies (e.g., 3-D projectors or displays, interactive tables)?]	SFJ	
1b	sf_j8	When thinking about the digital technology infrastructure at your school, what is the availability of… [technical support?]	SFJ	
1b	sf_k1	When thinking about the digital technology infrastructure at your school, what is the availability of… [instructional support for integrating digital technologies into classes?]	SFK	Very Poor, Poor, Fair, Good, Very Good
1b	sf_k2	When thinking about the support for digital technology at your school, what is the availability of… [Training sessions on how to use hardware and software?]	SFK	
1b	sf_k3	When thinking about the support for digital technology at your school, what is the availability of… [Professional development sessions on how to integrate digital technologies into lessons?]	SFK	
1b	sf_k4	When thinking about the support for digital technology at your school, what is the availability of… [An academic support person able to come into a class to model use of digital technologies with students?]	SFK	
1b	sf_k5	When thinking about the support for digital technology at your school, what is the availability of… [Online support (e.g., FAQ, school or district help documents online, online discussion groups or email lists)?]	SFK	
1b	sf_k6	When thinking about the support for digital technology at your school, what is the availability of… [informal guidance from colleagues?]	SFK	
1b	sf_m1	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Technology support]	SFM	Strongly Hinders, Hinders, Neither Hinders nor Helps, Helps, Strongly Helps, N/A
1b	sf_m2	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Technology reliability]	SFM	
1b	sf_m3	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Internet availability]	SFM	
1b	sf_m4	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Wireless Internet availability]	SFM	

(continued

RQ	ID*	Survey Question (Factors Supporting Technology Use)	Factor	Response Options
1b	sf_m5	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Overall technology access]	SFM	
1b	sf_m6	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [State standards]	SFM	
1b	sf_m7	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Standardized assessments]	SFM	
1b, 2	sf_m8	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Overall funding]	SFM	
1b	sf_q1	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Available time with students]	SFQ	
1b	sf_p1	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [The number of students who bring a device]	SFP	Strongly Hinders, Hinders, Neither Hinders nor Helps, Helps, Strongly Helps, N/A
1b	sf_p2	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Students have a variety of devices]	SFP	
1b	sf_l1	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [The culture of the subject you teach]	SFN	Strongly Hinders, Hinders, Neither Hinders nor Helps, Helps, Strongly Helps, N/A
1b	sf_q2	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Time to plan BYOD implementation.]	SFQ	Strongly Hinders, Hinders, Neither Hinders nor Helps, Helps, Strongly Helps, N/A
1b	sf_q3	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Time available to discuss BYOD issues with other teachers]	SFQ	
1b	sf_n2	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Other teachers' attitudes and beliefs]	SFN	
1b	sf_r1	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Your own knowledge and skills]	SFR	Strongly Hinders, Hinders, Neither Hinders nor Helps, Helps, Strongly Helps, N/A
1b	sf_r2	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Your own attitudes and beliefs]	SFR	
1b	sf_n3	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Student knowledge and skills]	SFN	
1b	sf_n4	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [School or district administration]	SFN	
1b	sf_n5	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Parents]	SFN	
1b	sf_n6	Please indicate the degree to which the following items hinder you or help you implement BYOD in your classroom. [Community]	SFN	

(continued)

RQ	ID*	Survey Question (Factors Supporting Technology Use)	Factor	Response Options
1b	sf_s1	Please agree or disagree with the following statement: [Our school has an appropriate written policy on the use of digital technology.]	SFS	Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree

*Not necessarily sequential

Table E5

Demographics

RQ	ID	Survey Question	Factor	Response Options
	de_b1	Demographic information [School Type]	de_b1	Public, Independent - Secular, Independent - Religious, Public Charter, Other
	de_b2	Demographic information [School Setting]	de_b2	Urban, Suburban, Town, Rural, Remote, International (non-North America), Other
	de_b2a	Demographic information [Is your school in North America?]	de_b2a	No, Yes
	de_c1	How many years have you been… [teaching in schools?]	de_c1	0-2 Years, 3-5 Years, 6-10 Years, 11-15 Years, and More Than 15 Years
	de_c2	How many years have you been… [using digital technologies professionally?]	de_c2	0-2 Years, 3-5 Years, 6-10 Years, 11-15 Years, and More Than 15 Years
	de_d1	What is your main teaching responsibility? [What school level do you mainly teach?]	de_d1	Pre-primary, Primary / Elementary, Middle School / Junior High, High School, Vocational / Career Ed.
	de_e1	What subjects do you teach? [Elementary self-contained]	DEE	
	de_e2	What subjects do you teach? [Elementary - other]	DEE	
	de_e3	What subjects do you teach? [Computer Science or Computer media]	DEE	
	de_e5	What subjects do you teach? [English/Language Arts]	DEE	
	de_e6	What subjects do you teach? [Other Language]	DEE	
	de_e7	What subjects do you teach? [History or Social Studies]	DEE	
	de_e8	What subjects do you teach? [Mathematics]	DEE	
	de_e9	What subjects do you teach? [Performing Arts]	DEE	
	de_e10	What subjects do you teach? [PE]	DEE	
	de_e11	What subjects do you teach? [Science]	DEE	
	de_e12	What subjects do you teach? [Visual Arts]	DEE	
	de_e13	What subjects do you teach? [Other (please List)]	DEE	

(continued)

Table E6

Summative Factors: Teacher Knowledge and Use of Digital Technology

Factor ID	# Survey Items	Cronbach's α	Factor Description (Teacher Knowledge and Use of Digital Technology)	Short Reference
TKA	6	0.87	Ability to use technology for teaching and administrative tasks.	Teacher Technology Use
TKB	6	0.88	Knowledge in helping students do specific learning or productivity tasks with the Internet.	Teacher Specific TPK
TKC	4	0.84	Knowledge of integrating technologies in teaching and learning.	Teacher General TPK
TKD	5	0.78	Judgment of support for using technology by various administrators.	Administrator Technology Support
TKE	10	0.82	Frequency of use of various technologies.	Teacher Technology Use Frequency

Note. TPK (technological pedagogical knowledge) follows the characterization of Mishra and Koehler (2006).

Table E7

Summative Factors: Student Use of Digital Technology

Factor ID	# Survey Items	Cronbach's α	Factor Description (Student Use of Digital Technology)	Short Reference
SUA	10	0.83	Frequency of student use of primarily non-collaborative technologies and actions.	Student Solo Technology Use
SUB	9	0.82	Frequency of student use of collaboration and presentation technologies for learning.	Student Collaborative Technology Use
SUC	6	0.87	Incorporates personal relevancy and uncertainty for students in learning environment.	Real World Connections
SUD	6	0.78	Incorporates shared control and negotiation for students in learning environment	Student Communal Involvement
SUE			Change in frequency of teacher use of technology in the classroom over recent years.	

Table E8

Summative Factors: Bring Your Own Device Program Specifics

Factor ID	# Survey Items	Cronbach's α	Factor Description (Bring Your Own Device Program Specifics)	Short Reference
BYA	2	0.77	Overall evaluation of BYOD.	Teacher BYOD Evaluation
BYB			Perception of BYOD.	BYOD Perception
BYC			Features of the specific BYOD program.	
BYD			Estimates of student use of BYOD.	

(continued)

Factor ID	# Survey Items	Cronbach's α	Factor Description (Bring Your Own Device Program Specifics)	Short Reference
BYE			Available options when students are, for whatever reason, unable to bring a device to a class.	
BYF			Estimates of frequency of devices brought by students.	
BYG			Observations of how students learn to use their devices.	
BYH			Equity of BYOD.	
BYJ			Open response about how BYOD Equity is addressed in the school.	
BYK			Open response about BYOD program effectiveness in the school.	
BYM	4	0.95	Attitude towards BYOD.	Teacher BYOD Attitude
BYN			General questions about the use of BYOD in the school.	
BYP			School BYOD policy accessibility.	
BYQ			Open Response about how teachers would explain the program to their students.	

Table E9

Summative Factors: Factors Supporting Technology Use

Factor ID	# Survey Items	Cronbach's α	Factor Description (Factors Supporting Technology Use)	Short Reference
SFJ	8	0.70	Availability of school-provided equipment or technologies.	Technology Availability
SFK	6	0.90	Availability of professional support for using technologies or integrating technologies into the classroom.	Professional Development Support
SFM	8	0.88	First order supports or barriers to implementing BYOD in the school.	Specific External Factors
SFP			Variety of devices and number of students bringing devices as a first order support or barrier.	
SFN	6	0.73	Human factor supports or barriers (external first order barriers).	Overall Atmosphere
SFQ	3	0.78	Time available with students, for BYOD planning, or for BYOD discussions with colleagues.	Teacher Time Availability
SFR			Reported human factor supports or barriers internal to the teacher (second order barrier).	
SFS			Report of whether the school has an appropriate written policy on the use of digital technology.	

Table E10

Summative Factors: Demographics

Factor ID	Factor Description (Demographics)	Short Reference
DEB	School Information.	
DEC	Professional Longevity.	
DED	Teaching Level.	
DEE	Teaching Subjects.	

APPENDIX G

Transcript Code Book

The following codebook was used for coding the interview transcripts. The codes were derived based on the survey categories in order to support triangulation of the data.

Transcript Code Book Instructions.

The codes below are used to code interview transcripts from the study, and the codes are organized into categories. One or more codes based on factors in the survey. Coding only applies to the interviewee and not to the interviewer. Code each instance where the context is different from the previous use of the code. The unit of analysis is a response.

Constructivist Category

- **Constructivist** - Code for any context that implies constructivist principles, e.g., real world connections, students have choice in assignments or learning, students build meaning with others or collaborate with others, etc. These are not technology tools nor are they necessarily under constructivist principles. It should be something that is clear that the teacher is creating the structure. For example, one student helping another solve a tech problem is not necessarily constructivist unless the teacher created the structure that makes it permissible to do so.

Demographics Category

Code for each of the items below on each transcript to collect demographic information about the participant.

- **BYOD Model**
- **Donation**
- **School Location**
- **School Setting**
- **School Type**
- **Teacher Level**
- **Years Digital Technology Use**
- **Years doing BYOD**
- **Years Teaching**

Equity Category

- **Equity belief** - Items that reveal something about the teacher's beliefs about equity of BYOD or equity of access in BYOD. Do not include items that reveal how equity is actually happening.

- **Equity practice** - Items that reveal how equity with BYOD is actually occurring in the school or the teacher's classroom. This may include school-provided devices for students without, students sharing, or possibly not attempt at providing a device to a student without.

Perceptions Category

- **BYOD perceptions or attitude** - Teacher perceptions or attitude towards BYOD. Includes perceptions or attitude where the interviewee discusses other teacher's perceptions or attitudes.
- **Teacher behavior perception** - Teacher perceptions of student behavior with BYOD. Includes perceptions where the interviewee discusses other teacher's perceptions.

Strengths and Challenges Category

- **Administrator support** - Commitment participation of district administrators, school administrator(s), school board, technology directors, etc.
- **External and institutional support** - Tech support, internet, overall tech access, funding levels, standards, standardized assessments, etc.
- I**nstructional support** - Availability of instructional support, training, PD, academic support person, online access, working with colleagues formally or informally, etc.
- **Social infrastructure** - Subject culture, parent or school social culture, etc.
- **Technology availability** - Availability of devices for teachers, devices for students, Wi-Fi, fast internet, display technologies
- **Time availability** - Time teachers have available with students, or to work with other teachers for planning/doing BYOD, or for their own planning purposes.

Student Access Category

When a student does not have a device capable of accessing the Internet, how often does a student…

- **Borrows from another** - borrows a device from another student.
- **No access** - does not have access to any device for the period
- **Partners with another** - Shares a device with another student.
- **Uses school owned device** - use a school-owned laptop, desktop, or tablet?

Student Device Learning Category

How does a student learn how to use his or her device?

- **Learn from assignments** - indicates students learned something about using their devices through working on their assignments. In order to be coded, it should be possible to discern in the statement that students learned something about their device OR that they did not learn anything.
- **Learn from each other** - indicates students learned something about using their devices from each other. In order to be coded, it should be possible to discern in the statement that students

learned something about their device OR that they did not learn anything even though they were working with other students.

- **Learn other ways** - Indicates students learned in other ways that may not have to do with assignments and that are not directly attributable to students working with each other. This can be indicated by statements like, “students know…” or “the teacher helped”.

Student Device Uncertainty Category

What happens when the student does not know how to do something with his device? Use the appropriate selections it is possible for a statement to have several codes

- **Other students help** - Other students offer to help the student.
- **Outside assistance** - Assistance from others not in the classroom
- **Remains uncertain** - The student does not learn to do the task.
- **Searches Internet** - The student searches the Internet for help.
- **Student asks others** - The student independently seeks help from other students.
- **Teacher helps** - The teachers helps the student.

Technology Use Category

How is the technology used by students and teachers?

- **Teaching Use** - Technology used by the teacher for teaching
- **Administrative Use** - Technology used by the teacher for doing admin tasks
- **PD Use** - Technology used for professional development.
- **Student Solo Use** - Student technology that is used non-collaboratively for approved purposes. This is a bit misleading, but describes times when students work alone. An example might be *research*. Unless it can be clear from the context that students are working together, code as solo. Does not include items that are behavior issues, such as being on twitter or Angry Birds when they should be doing something else. Those are coded in behavior.
- **Student Collaborative Use** - Technology used for collaboration or communication, or presentation, or areas where students are collaborating for approved purposes. Items known to be primarily collaborative, e.g. Google Docs, should be coded as collaborative. Does not include items that are behavior issues, such as being on twitter or Angry Birds when they should be doing something else. Those are coded in behavior. Does not include just the mention of the tool, but use of the tool.
- **Tools** - Technology software tools used in BYOD. Does not include general mention of smartphones, tablets, game console, or mention of OS’s, etc, but of things used for teaching and learning.

APPENDIX H

Permissions

TPACK Image Permission

The following quote is from TPACK.org (http://tpack.org):

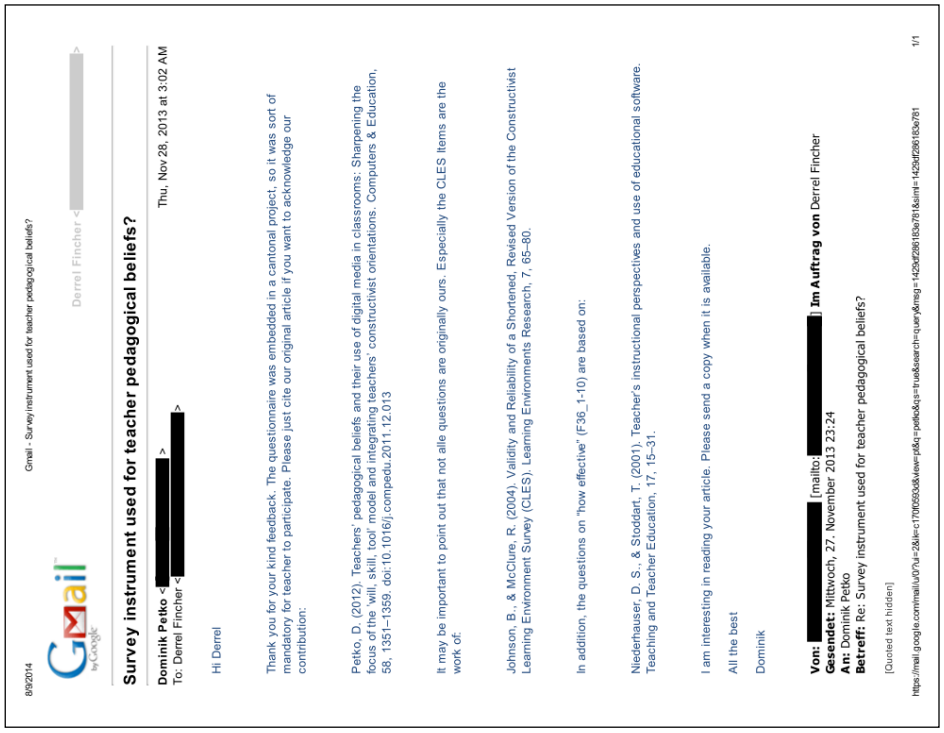
Using the image in your own works

Others are free to use the image in non-profit and for-profit works under the following conditions.

- The source of the image is attributed as http://tpack.org
- The author of the work does not make any claim to copyright over the image
- The publisher of the work does not make any claim to copyright over the image
- The image is captioned or credited as “Reproduced by permission of the publisher, © 2012 by tpack.org” (or something equivalent)

If those conditions are met, there is no need to contact tpack.org, Matthew Koehler, or Punya Mishra. We hereby grant permission to use the image under the above stipulations. This appendix contains the communications used to request permissions.

Permission to Use Existing Instruments



8/9/2014 Gmail - Survey instrument used for teacher pedagogical beliefs?

Gmail by Google

Survey instrument used for teacher pedagogical beliefs?

Dominik Petko < [redacted] > Thu, Nov 28, 2013 at 3:02 AM
To: Derrel Fincher < [redacted] >

Hi Derrel

Thank you for your kind feedback. The questionnaire was embedded in a cantonal project, so it was sort of mandatory for teacher to participate. Please just cite our original article if you want to acknowledge our contribution:

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

It may be important to point out that not alle questions are originally ours. Especially the CLES items are the work of:

Johnson, B., & McClure, R. (2004). Validity and Reliability of a Shortened, Revised Version of the Constructivist Learning Environment Survey (CLES). Learning Environments Research, 7, 65–80.

In addition, the questions on "how effective" (F36_1-10) are based on:

Niederhauser, D. S., & Stoddart, T. (2001). Teacher's instructional perspectives and use of educational software. Teaching and Teacher Education, 17, 15–31.

I am interesting in reading your article. Please send a copy when it is available.

All the best

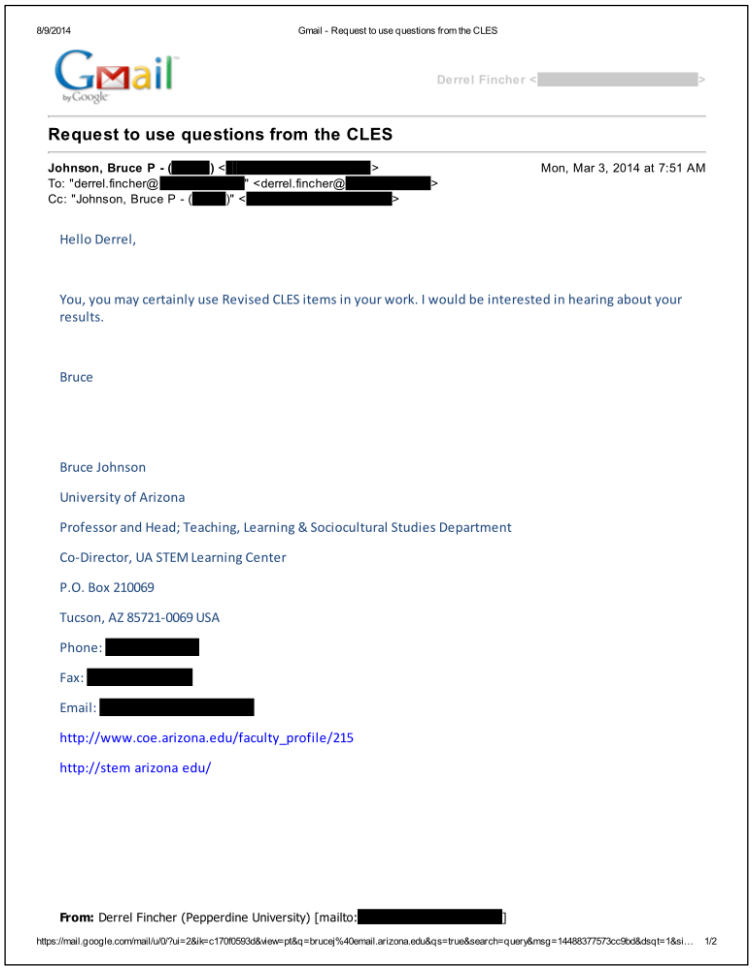
Dominik

Von: [redacted] [mailto: [redacted]] **Im Auftrag von** Derrel Fincher
Gesendet: Mittwoch, 27. November 2013 23:24
An: Dominik Petko
Betreff: Re: Survey instrument used for teacher pedagogical beliefs?

[Quoted text hidden]

https://mail.google.com/mail/u/0/?ui=2&ik=c17bf0935d&view=pt&q=petko&qs=true&search=query&msg=1425aff29b183e7818&siml=1425aff29b183e781 1/1

Figure H1. Permission to use survey instrument for teacher pedagogical beliefs.



8/9/2014 Gmail - Request to use questions from the CLES

Gmail by Google

Derrel Fincher <[redacted]>

Request to use questions from the CLES

Johnson, Bruce P - ([redacted]) <[redacted]> Mon, Mar 3, 2014 at 7:51 AM
To: "derrel.fincher@[redacted]" <derrel.fincher@[redacted]>
Cc: "Johnson, Bruce P - ([redacted])" <[redacted]>

Hello Derrel,

You, you may certainly use Revised CLES items in your work. I would be interested in hearing about your results.

Bruce

Bruce Johnson

University of Arizona

Professor and Head; Teaching, Learning & Sociocultural Studies Department

Co-Director, UA STEM Learning Center

P.O. Box 210069

Tucson, AZ 85721-0069 USA

Phone: [redacted]

Fax: [redacted]

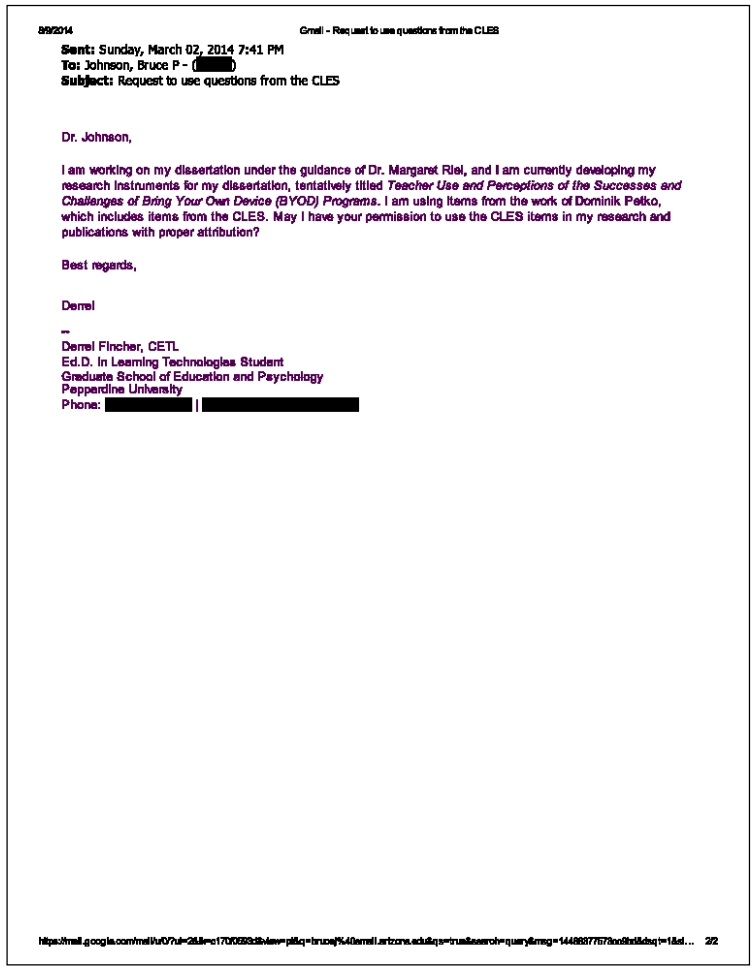
Email: [redacted]

http://www.coe.arizona.edu/faculty_profile/215

http://stem arizona edu/

From: Derrel Fincher (Pepperdine University) [mailto:[redacted]]

https://mail.google.com/mail/u/0/?ui=2&ik=c170f0593d&view=pt&q=brucej%40email.arizona.edu&qs=true&search=query&msg=14488377573cc9bd&dsqt=1&si… 1/2



8/9/2014 Gmail - Request to use questions from the CLES

Sent: Sunday, March 02, 2014 7:41 PM
To: Johnson, Bruce P - ([redacted])
Subject: Request to use questions from the CLES

Dr. Johnson,

I am working on my dissertation under the guidance of Dr. Margaret Riel, and I am currently developing my research instruments for my dissertation, tentatively titled *Teacher Use and Perceptions of the Successes and Challenges of Bring Your Own Device (BYOD) Programs*. I am using items from the work of Dominik Petko, which includes items from the CLES. May I have your permission to use the CLES items in my research and publications with proper attribution?

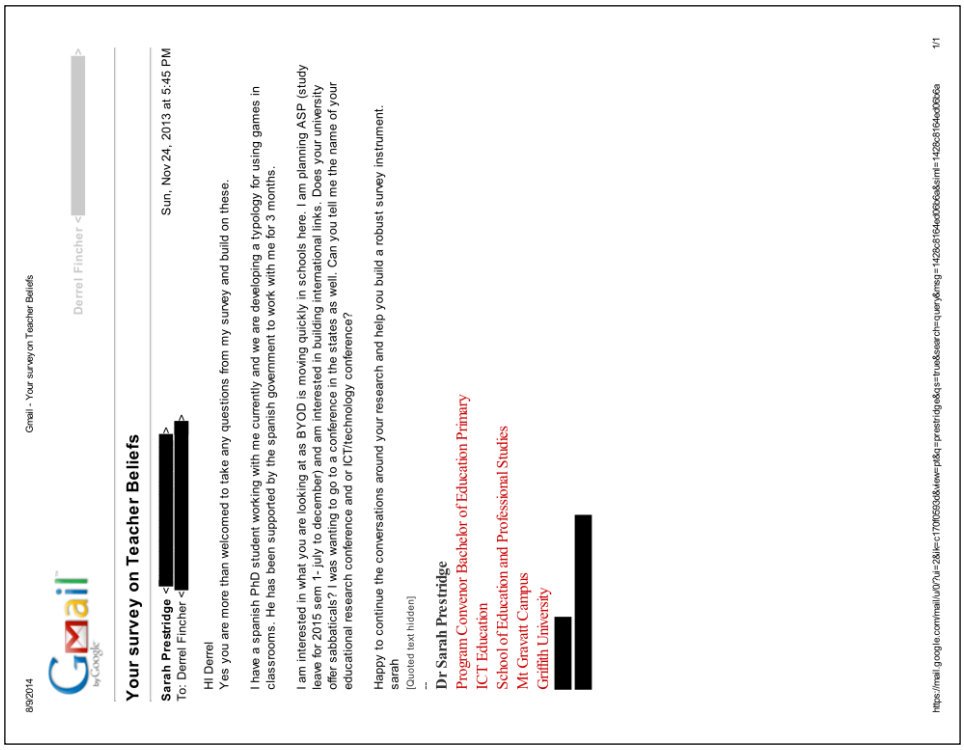
Best regards,

Derrel

--
Derrel Fincher, CETL
Ed.D. in Learning Technologies Student
Graduate School of Education and Psychology
Pepperdine University
Phone: [redacted] | [redacted]

https://mail.google.com/mail/u/0/?ui=2&ik=c170f0593d&view=pt&q=brucej%40email.arizona.edu&qs=true&search=query&msg=14488377573cc9bd&dsqt=1&si… 2/2

Figure H2. Permission to use the Constructivist Learning Environment Survey in the research.



8/9/2014 Gmail - Your survey on Teacher Beliefs

Gmail

Derrel Fincher <[redacted]>

Your survey on Teacher Beliefs

Sarah Prestridge <[redacted]> Sun, Nov 24, 2013 at 5:45 PM
To: Derrel Fincher <[redacted]>

Hi Derrel
Yes you are more than welcomed to take any questions from my survey and build on these.

I have a spanish PhD student working with me currently and we are developing a typology for using games in classrooms. He has been supported by the spanish government to work with me for 3 months.

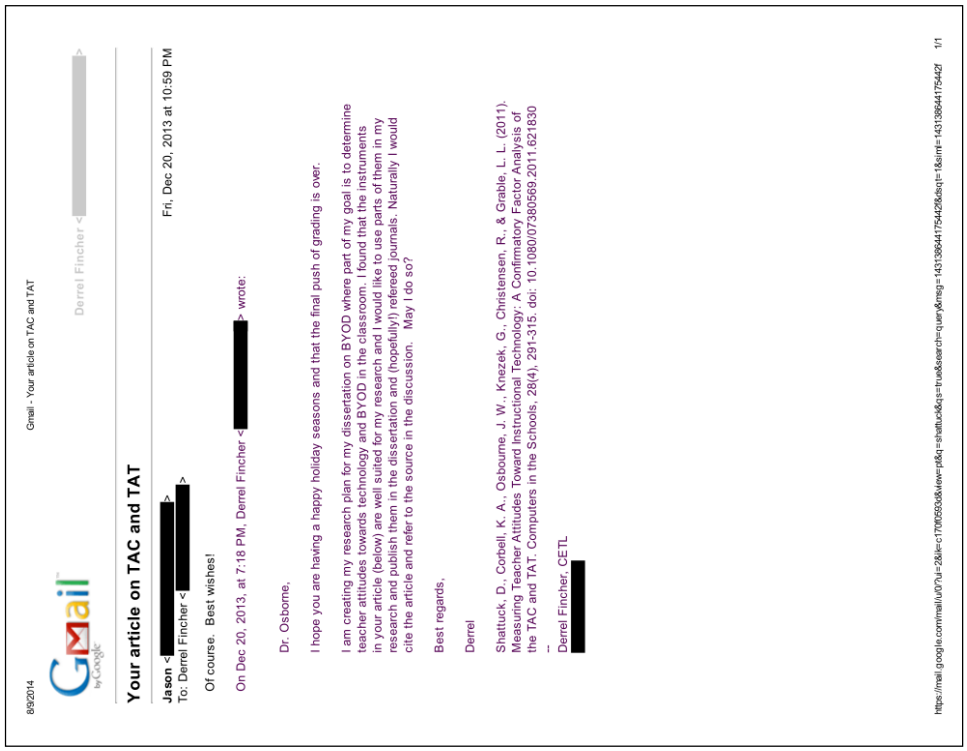
I am interested in what you are looking at as BYOD is moving quickly in schools here. I am planning ASP (study leave for 2015 sem 1- july to decembe) and am interested in building international links. Does your university offer sabbaticals? I was wanting to go to a conference in the states as well. Can you tell me the name of your educational research conference and or ICT/technology conference?

Happy to continue the conversations around your research and help you build a robust survey instrument.
sarah
[Quoted text hidden]

Dr Sarah Prestridge
Program Convenor Bachelor of Education Primary
ICT Education
School of Education and Professional Studies
Mt Gravatt Campus
Griffith University
[redacted]

https://mail.google.com/mail/u/0/?ui=2&ik=c17f0f5930&view=pt&q=prestridge&qs=true&search=query&msg=1429c8164ed0f0b6a&siml=1429c8164ed0f0b6a 1/1

Figure H3. Permission to use survey on teacher beliefs.



8/9/2014 Gmail - Your article on TAC and TAT

Gmail

Derrel Fincher <[redacted]>

Your article on TAC and TAT

Jason <[redacted]> Fri, Dec 20, 2013 at 10:59 PM
To: Derrel Fincher <[redacted]>

Of course. Best wishes!

On Dec 20, 2013, at 7:18 PM, Derrel Fincher <[redacted]> wrote:

> Dr. Osborne,
>
> I hope you are having a happy holiday seasons and that the final push of grading is over.
>
> I am creating my research plan for my dissertation on BYOD where part of my goal is to determine teacher attitudes towards technology and BYOD in the classroom. I found that the instruments in your article (below) are well suited for my research and I would like to use parts of them in my research and publish them in the dissertation and (hopefully!) refereed journals. Naturally I would cite the article and refer to the source in the discussion. May I do so?
>
> Best regards,
>
> Derrel
>
> Shattuck, D., Corbell, K. A., Osbourne, J. W., Knezek, G., Christensen, R., & Grable, L. L. (2011). Measuring Teacher Attitudes Toward Instructional Technology: A Confirmatory Factor Analysis of the TAC and TAT. Computers in the Schools, 28(4), 291-315. doi: 10.1080/07380569.2011.621830
> --
> Derrel Fincher, CETL
> [redacted]

https://mail.google.com/mail/u/0/?ui=2&ik=c17f0f5930&view=pt&q=shattuck&qs=true&search=query&msg=1431386441754429&dsqt=1&siml=1431386441754429 1/1

Figure H4. Permission to use the Teacher Attitude toward Computers (TAC) and Teacher Attitude toward Technology (TAT) instruments.