THE IMPACT OF STUDENT ACHIEVEMENT BASED UPON THE DIFFERENCES BETWEEN TEACHER PERCEPTION OF BLENDED LEARNING AND THEIR TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE

by

Jason DeWayne Pizzino

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

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APPROVED BY:

Dr. Rebecca Lunde Ed.D., Committee Chair

Dr. Joanne Gilbreath Ed.D., Committee Member

ABSTRACT

The purpose of this quantitative, correlational research study was to understand if student benchmark scores in a blended learning environment were predicted by teachers' Technological Pedagogical Content Knowledge (TPACK). This study used a correlational methodology to examine if in a blended learning environment, teachers' perceptions of the TPACK score predict their students' scores on the second nine-weeks benchmark test in a middle school mathematics. Bivariate linear regression was used for data analysis to determine the predictive relationship between teachers' TPACK-21CL survey score and their students' second nine weeks benchmark score using the latest SPSS software. The data was collected from a Virginia middle school in one southwestern district using their benchmark test and the TPACK survey to determine if a teachers' perception could impact students' achievement. The teachers (n = 5) participating in this study completed a survey the TPACK survey on SurveyMonkey. The sample included 316 students. The results indicated that there was statistically predictive relationship between teachers' TPACK-21CL survey and students' second nine weeks benchmark scores. Furthermore, this study was conducted during the pandemic and should be repeated again using other subjects. This study had a limited amount of participants and future studies should be repeated including other subjects and both students and teachers would be familiar with Chromebooks.

Keywords: blended learning, benchmark, TPACK

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Technological Pedagogical and Content Knowledge (TPACK)

National Council of Teachers of Mathematics (NCTM)

Information and Communications Technology (ICT)

CHAPTER ONE: INTRODUCTION

Overview

Mobile devices are an essential tool in most classrooms today. They allow for classrooms to operate using remote instruction instead of in-person traditional teaching. The mobile devices that can be used inside a classroom include smartphones, Chromebooks, tablets, and other devices that can connect to a wireless network. The perception in education integration of technology into the mathematics classroom the better it will help students learn and understand mathematical concepts (Fabian et al., 2018). The use of digital technology such as videos, online textbooks, and online resources to instruct students has been increasing since electronics was introduced to the classroom. This has allowed for a blended learning classroom to flourish by having traditional face-to-face instruction with videos to either teach or remediate students who are having difficulty learning material. The technology used in a blended setting requires a teacher to change and integrate it into their instruction. Teachers' perceptions of technology use in the classroom may have influence on student outcomes. This first chapter will cover the background of technology in the classroom, the problem statement, purpose statement, research question, and the significance of the study.

Background

The National Council of Teachers of Mathematics (NCTM) suggests that an excellent mathematics program integrates mathematical tools and technology as essential resources to help students learn (King, 2017). The norm in education over the past decade has been to integrate more technology into the classroom as districts are financially able to purchase it (Orlando & Attard, 2016). This funding allows for new technology to be bought or purchased, but technology changes so quickly the teachers lack the time to fully test the technology before it is

used in the classroom, so it often goes untested (Shariman et al., 2017). The introduction of using a mobile device in the classroom or a blended learning environment requires teachers to develop a framework and lessons that can incorporate the use of the technology effectively in the classroom (Barreh & Abas, 2015; Phillips et al., 2016).

This constant change in the teaching environment forces teachers to look at different pedagogy to integrate into their classrooms. The determination about what technology and learning activities teachers used in the classroom comes from what the district provides (Rice & Ortiz, 2021). How a teacher incorporates technology into classroom instruction may be a factor in students not learning the mathematics content effectively (Burden & Kearney, 2017). The Burden and Kearney (2017) study showed that in some situations introducing technology into the classroom may cause a decrease in student achievement which is due to the inability of teachers to learn software and applications effectively for classroom use.

Digital learners are drawn to the introduction to new technology into the classroom because of the constant exposure and immersion of technology in society today (Onyema & Daniil, 2017; Orlando & Attard, 2016). The amount of exposure to technology and how it is used in everyday life has helped to students to be able to bring that knowledge to the classroom and flourish when technology is used in the classroom (Onyema & Daniil, 2017; Orlando & Attard, 2016). In classrooms that the majority of students can understand and use technology effectively in the classroom, educators began integrating technology into the classroom to enhance student learning (Burden & Kearney, 2017). The increase in mobile technology, especially in mathematics, has been increasing professional development to increase the use of new technology in daily learning activities (Burden & Kearney, 2017). Pre-service teachers (PSTs) have grown up immersed throughout their non-academic lives with technology, and teacher

education programs allow them to have their personal perspective of how they utilize technology in their educational assignments (Burden & Kearney, 2017).

The integration of mobile devices that have internet capabilities started to become the norm in all subjects over the past few decades. A potential problem with using this technology is when devices are not working, causing students to miss instruction that can only be completed on devices (Johnson, 2019). In the past, integrating technology in the mathematics classroom included technology like four-function calculators, scientific calculators, graphing calculators, and using various computer programs like geometry sketchpad on the projector. These practices have changed since the inclusion of mobile technology in the post-PC era where people are more use mobile devices, phones, over personal computers (Burden & Kearney, 2017). This is helping to drive the change from the teacher-centered delivery to students for years, to helping them to take charge in their learning, allowing for continual data to be collected from the various programs being used in the classroom (Burden & Kearney, 2017).

The new pedagogy calls for teachers to be digitally focused on their teaching styles so they can reach students in multiple ways because the capabilities of the technology available to them (Burden & Kearney, 2017). The focus for the new classroom requires that teachers use various forms of interactive video to instruct their students. Afify (2020) stated that videos that are less than six minutes are effective in helping students to develop understanding and have cognitive retention of learning the content. Teachers who can adapt to the different educational strategies such as incorporating technology into the classroom are able to provide an effective blended learning environment for students and promote learning practices (Afify, 2020). Using textbooks that have adapted use both a digital version and paper version allow for activities for teachers to use in a blended learning environment by providing resources (Fabian et al., 2018).

Using technology in the classroom requires the teacher use good instructional practices since this can affect the educational function of the technology (Dalby & Swan, 2019). Incorporating technology shows effective use of teaching practices. These practices help to create strategies that are needed for an enhancement of the student experience allowing them to use metacognitive strategies and feedback (Tourón et al., 2019). These changes are needed influence in a blended classroom environment in which the instructor is attempting to merge both the traditional teaching practices and modern teaching by using mobile learning to enhance the instruction (Tourón, et al., 2019).

Teachers need an understanding of both teacher directed instruction combined with a technology aspect to teach and engage learning in today's classroom (Tourón, et al., 2019). The shift in the teaching model began in 2010 when tablets were first introduced (Orlando & Attard, 2016). Johnson (2019) mentioned that some of the tensions in teaching are toward technology integration. This helps to shape the classroom because the technologies that is used by teachers are not always predictable depending on multiple factors from funds to purchase devices to teacher training on devices are not always predictable. The use of digital textbooks and materials instead of the traditional paper textbook has become mainstream since the pandemic started and before the pandemic technology integration that had access to technology (Rice & Ortiz, 2021).

In classrooms that do have devices, sometimes students will hide that they are not understanding by using a device incorrectly or pretend to be working to get out of doing classwork (Johnson, 2019). Teachers may not know enough about the various devices to help the students which may cause them to fall behind in understanding content. What actions help students to fall behind in content that is being delivered in the traditional part of classroom instruction and classwork (Johnson, 2019).

In the digital classroom students may lose focus and not pay attention to the teacher because they are paying more attention to the digital device. This could happen because of student's with short attention spans may lose interest after watching a video for longer than six minutes (Afify, 2020). Mcgloinet et al. (2017) noted some students have multiple distractions during the time home learning experience is taking place, which can hinder the learning process. This is why it is important for teachers to seek digital materials that are aligned to the curriculum to help students learn (Rice & Ortiz, 2021). It is also important to outline learning activities to be based to help students to focus on learning by keeping a precise list of activities that needed to be completed (Marco et al., 2017). This allows students to follow a detailed list of activities and completing a list of activities that could help students to stay focused and complete tasks.

The area of concern with the integration of technology is the speed at how that change has an impact on students end of course test. The pandemic forced many districts to go virtual and there was a need for teachers to use digital materials for their classrooms (Rice & Ortiz, 2021). A district may decide to use a version of the technology used over the pandemic to have fully virtual classes, but others may use the technology to have a blended form of instruction (Rice & Ortiz, 2021). The difference in technology programs and the methods required for their use in the classroom when this change happens at the district level does not allow teachers enough time to adapt them into their pedagogies (Burden & Kearney, 2017).

The integration of technology into the classroom is fostered through using the Technological Pedagogical and Content Knowledge (TPACK) framework (Koehler & Mishra, 2005). TPACK helps to evaluate technology integration into the classroom by looking at practice and theory that teachers use to help students in the classroom (Liang & Luo, 2015). The increase

in the functionality of the classroom due to the various types of technology has helped to change the design of classroom learning.

The increase of technology in the classroom has been responsible for the technology-enhanced learning (TEL) design for classroom use, which is a complex design for teachers at any level in today's educational environment (Papanikolaou et al., 2017). There is an emphasis in some school districts to use technology to enhance engagement in activities in the mathematics classroom, which is what TPACK is trying to accomplish (Liang & Luo, 2015). This is a challenge because the TEL requires teachers shape their content through a variety of technical challenges in the classroom. This change includes working with digital media integration, curriculum formats that work with online formats, and other activities that allow for digital learning to be effective (Papanikolaou et al., 2017).

The challenges of TEL demonstrate the importance of the TPACK framework and trying to help teachers with the integration of new software and applications. Teachers have a lack of training when it comes to integration of new technology in the classroom depending on the resources of their school district. These cause issues in the classroom and downtime in learning content that is important for student achievement (Honey, 2018). Any change to the curriculum causes attitudes with teachers to be disrupted with multiple emotions about the new tools, which have either positive or negative consequences (Dalby & Swan, 2019). The TPACK framework shows how teachers understand the technology they are implementing in the classroom and how they understand the pedagogical approach that affects the integration of new technology into the classroom (Honey, 2018).

This study used a variation of Koehler and Mishra’s (2005) TPACK framework developed by Koh et al. (2015), which evaluates how a teachers' perception of their TPACK

influences lesson plan design and design dispositions of technology. One reason for using the TPACK framework is because it helps to evaluate technology integration into the classroom. The framework helped to identify if lesson design practices including technology is influenced by the perceptions of the teachers' TPACK. Looking at the TPACK knowledge teachers integrate information and communications technology (ICT) practice in the classroom to enhance lesson engagement and student learning (Liang & Luo, 2015).

The amount of technology usage can vary differently depending on the content area being taught. Using the TPACK as a framework helps to collect data showing how teachers' technical knowledge could have an impact on how they deliver the content in a blended learning environment in a mathematics classroom (Ahmed Qasem & Viswanathappa, 2016). TPACK helps to emphasize how the use of technology in the classrooms helps in the overall lesson design practices by the teacher and how much ICT impacts a mathematics classroom (Liang & Luo, 2015). The TPACK framework helped determine if the perception of technology integration impacts lesson plan designs and has meaningful learning dimensions to engage students (Koh et al., 2015). Lesson design and keeping students engaged are important in a blended classroom because of the technology is used more than in a traditional classroom, which according to Honey (2018) that teachers' beliefs and attitudes impact learning. This blended learning environment is a different approach because of the combination of both traditional and virtual learning causing changes to the pedagogical approach when adapting technology into the lesson design for instruction. Papanikolaou et al. (2017) showed teaching in a blended learning environment requires more work than a traditional classroom because of this change in the pedagogical approach. This is because teachers are expected to be both a content expert and an online learning expert. The integration is constantly evolving because of the change and

advancements in classroom technology, which is a source of frustration with teachers as they learn to use them (Honey, 2018).

The TPACK theoretical framework helping to determine if teachers' technological knowledge has an impact on student achievement in a blended learning environment. This was analyzed by understanding teachers' perceptions of how they use technology in their classroom checking to see if there has or has been an impact on their lesson plan designs for delivering content (Koh et al., 2015). The TPACK framework helps to show how the advancements of ICT are integrated into the classroom, seeing if the perception of this integration has an impact on student achievement (Koh et al., 2015). Understanding teachers' perception of technology in a blended classroom was determined by teachers' amount of lesson design activities that use technology. The impact of the perception toward technology by teachers has influence on student achievement (Koh et al., 2015). Using the TPACK framework to understand the lesson design processes and teachers' perceptions toward technology can help teachers while instructing in a blended learning environment. The TPACK framework was work as a guide to finding if the current process of designing lessons that are engaging for students and helping with successful student achievement. The teachers feel uncomfortable with the new technology because of a lack of training and support or unwillingness to change their pedagogy (Burden & Kearney, 2017).

Problem Statement

The emergence of technology in the classroom has created the opportunity for a unique learning environment that combines both a traditional and a mobile learning environment (Tang & Chaw, 2016). The challenge of integrating a learning environment for rural middle school mathematics centered around pedagogy having both traditional and technology make it

challenging for teachers to know the right instructional methods that can benefit students. The idea of using mobile technology in the mathematics classroom and having a blended classroom has been building for years, since the expansion of different modes of delivery of instruction. The blended classroom which was not used before the pandemic was changed to that in rural areas during this time. The perceived usefulness of the technology in the classroom is important for teachers to understand and to enhance attitudes in a blended learning environment (Boshoff & Laher, 2017). Teachers who do not perceive that the technology can be useful in their classroom, or they have difficulty understanding the technology are less likely to ingrate the technology into lesson plan designs. Van Leeuwen (2018) stated future research needs to study student performance in a blended classroom. The change in pedagogy by integrating technology into daily lessons, the way teachers present the content to students, and how students use it to practice problems in a non-traditional setting is another gap in research suggested by Van Leeuwen (2018). Phillips et al. (2016) noted that there is a need to study the effects of switching to a blended classroom to understand if the results would be different after the novelty wears off while using the new format. The problem is that there is not enough research to determine if a teachers' perception of TPACK could impact students' achievement on a benchmark test in a middle school mathematics blended environment.

Purpose Statement

The purpose of this quantitative, correlational research study is to investigate the effects of teachers' perception of TPACK to see the impact it has on students' benchmark scores in a blended learning environment. This study used a correlational method to examine if a teachers' perception of the TPACK including information and communication technologies (ICT) in a blended learning environment predicts their students' scores on the second nine weeks

benchmark test. The study examined a sample taken from a rural middle school in the same district. The middle school in the research serves 926 students in grades sixth through the eighth grade with 70 teachers. The teachers took a TPACK survey, which measured teachers' TPACK knowledge and their perceptions to see if it could influence student achievement. The independent variable in this study was the TPACK survey that measured teacher perception of blended learning and teacher pedagogical content of mathematics teachers teaching sixth, seventh, eighth, with some teachers in the seventh and eighth grade teaching Algebra 1 or Geometry in a blended learning environment (n = 11). Teacher perception is how teachers use various resources to conduct their classroom and what they believe is the best way to deliver the content so that students can understand the material (Koh et al., 2015).

The dependent variable in this study was identified as the second nine-week benchmark test that is measuring student achievement in a blended learning environment. The students in the study were in mathematics classes between sixth, seventh, eighth, with some students in the seventh and eighth grade taking either Algebra 1 or Geometry (n = 520). There is a need to understand the impact of teachers' perceptions of blended learning the influence on student learning in middle school mathematics.

Significance of the Study

Changing from a traditional classroom to one that is taught both online and face-to-face is a challenging transition. This study aims to quantify how teachers' perceived notions of a blended classroom and the integration of technology into their lessons have an impact on their TPACK score. A lesson plan design that does not encompass all the technology available to a teacher could affect their students' achievement in middle school mathematics. The change from a classroom that does not use chromebooks to one that uses chromebooks them has been a

significant change to the pedagogy in a mathematics classroom. This is because teachers are now having to put significant content and engaging lessons together for students to have access to while not in a face-to-face environment. The central idea of teachers changing their pedagogy and integrating new technology in the classroom depends on how they change their daily habits from using worksheets to digital resources (Johnson, 2019). This study helps to show how teachers' perceptions impact student achievement in a blended learning environment. Previous research points to the conclusion that there is a lack of training for teachers when it comes to integrating technology into the classroom, which translates into a lack of confidence in using it in their pedagogy (Liang & Luo, 2015).

The significance of this study focused on the impact of student achievement by teacher perception and TPACK of a blended classroom. This was demonstrated through the ability to highlight approaches that are being used to influence student achievement during blended learning. Research has not all been positive about a blended learning environment (Wai et al., 2015). This is dependent on many factors such as location of schools and home internet availability, school funding not being available to purchase updated technology, and students getting distracted in class on technology instead of paying attention in class. Understanding a teacher’s perception toward a blended learning environment helps aid in creating an engaging classroom. This can happen through understanding technology that would be engaging, user-friendly, and easily adapted for classroom use (Wai et al., 2015).

Furthermore, this study used the TPACK survey to understand if teacher knowledge of technology has an impact on a hybrid classroom. Changing the teaching pedagogy from traditional to blended format depended on the teachers' beliefs and attitudes, which can impact student achievement (Honey, 2018). The district provides professional development at the

beginning of each school year with the new software that was used throughout the year and refresher courses for the technology provided by the district. The district provides training and refresher training on promethean boards, Canvas, and performance matters yearly to ensure teachers understand the programs that the district expects to be used in the classroom setting.

Molnar and Molnar (2017) stated that teachers who use more technology than just presentation tools help increase student performance because of increased student engagement in the classroom. This would apply to a blended classroom because it increases student opportunities through a changed pedagogy. This study, using the TPACK survey, helps to aid in the understanding of teachers' perceptions toward lesson plan design in a blended learning environment (Agyei & Voogt, 2015). The analysis of the survey was used to show if teachers are using technology adequately in a classroom environment that is only using a blended learning model. This provided the researcher with data and a theoretical analysis that help teachers develop the best practices to use in the integration of technology into a blended classroom, allowing for information to be collected that might be able to have a positive influence on the pedagogy in the mathematics teacher's classroom (Liang & Luo, 2015). Teachers' perceptions of their TPACK could impact the blended instructional pedagogy and student achievement in a middle school mathematics classroom.

Research Question

RQ1: How accurately can student achievement be predicted based on teacher perception of blended learning based on their Technology Pedagogical Content Knowledge?

Definitions

1. *Blended Learning* – combining learning taking place with internet, digital, and traditional learning in classrooms with the presence of teachers and students for part of the time. (Conijn et al., 2018).
2. *Design Dispositions* – refers to a teachers' design beliefs of their pedagogy that a teacher brings to design an activity to bring change to their classroom (Koh et al., 2015).
3. *Flipped Classroom* – refers to the delivery of the instructional content occurs outside the classroom and the instruction in the classroom students are working on guided practice and activities (Van Leeuwen, 2018).
4. *Hybrid Learning* – instruction of content happens in the classroom, which is supplemented by online resources by videos, class notes, and online learning programs (Van Leeuwen, 2018).
5. *Lesson Design Practices* – refers to teachers' approaches used for lesson design in their classroom (Koh et al., 2015).
6. *Teacher Perception* – refers to teachers' beliefs in what tools are to be used in classroom design strategies by using their preferred pedagogy, content delivery, and technological tools in their classroom (Koh et al., 2015).
7. *Technological Pedagogical Content Knowledge* – provides a framework for studying potential changes, integration of pedagogical knowledge, and understanding teachers Technological Knowledge (TK), Pedagogical Knowledge (PK), and subject Content Knowledge (CK) (Koehler & Mishra, 2005).

CHAPTER TWO: LITERATURE REVIEW

Overview

The use of technology in the classroom has increased over the past decade, especially in the mathematics classroom. The world population has access to the internet, which has caused everything to completely change making our lives dependent upon technology being important to change every aspect of our daily lives. The access to technology has helped to evolve mathematics from a paper and pencil classroom to one which relies upon mobile technology. Teachers now have access to collaboration tools, which can be used to help to engage students. Teachers need to change their pedagogy to fit the new classroom model and different way of thinking. The TPACK framework will be discussed in this chapter showing the integration of technology in the mathematics classroom can benefit all stakeholders. The second section will show how mobile technology is helping to create an engaging environment. The literature review will show the change from a traditional classroom to a blended classroom using mobile learning devices. The change from traditional calculators to mobile applications calculators influence motivations in the classroom. Finally, the literature will show that further research is needed to understand how teacher perception of blended learning influences student outcomes when learning in a blended classroom.

Theoretical Framework

The way technology has improved and changed over the past decade through the integration of it into classroom is a testament to how teachers are challenged to understand both technology and the content they present to students. Overall, this change has been important to show how teachers look at their classrooms and how students perceive learning in today's 21st-century environment. Shulman (1986) began looking at how pedagogical content knowledge can

make learning content either difficult or easy. The important thing is for teachers to understand the role technology is going to have in the classroom and it is important for them to have enough training to be able to use it effectively in the classroom (Shulman, 1986). The technological, pedagogical, and content knowledge (TPACK) framework looks at how the role of technology has had an impact on teaching (Swallow & Olofson, 2017).

TPACK started with the idea that a teacher's knowledge of content and pedagogy was important to the classroom environment (Shulman, 1986). The content knowledge was what a teacher knew about the subject area and the ability to explain the truths about the domain of a topic. Pedagogical content knowledge as referred to by Shulman (1986) was the knowledge that went beyond the knowledge of the subject area that helped to make representations of analogies and learning topics easy or difficult.

Effective integration of technology into the classroom is important when looking at TPACK, which is broken down into several different parts. Knowledge of Content (CK) relies upon a teachers' knowledge about the subject matter they are covering in their classroom. This includes knowledge and expertise about concepts, theories, and practices to develop knowledge in the area in which they are instructing (Koehler & Mishra, 2009). Knowledge of Pedagogy (PK) is knowledge of a teacher's practices and methods of teaching in the educational setting. PK allows for an understanding of different kinds of teaching methods that will help teach students in various educational settings, which could help teachers in general classroom management skills, lesson planning, and student assessment (Koehler & Mishra, 2009). Teaching a specific content area and combining both CK and PK help to make pedagogical content knowledge (PCK) (Graham et al., 2012; Koehler & Mishra, 2009). According to Shulman (1986) PCK is the

transformation of specific content knowledge to conditions that promote learning in the classroom.

Technology knowledge (TK) focuses on the understanding of technology, tools, and resources that teachers use to deliver content to students (Koehler & Mishra, 2009). A teachers' TK was combined with CK to form the technological content knowledge (TCK). TCK looks at a teachers' understanding of technology and a teachers' content knowledge to determine how it influences their decisions in the classroom regarding the use of technology. The data shows how the influence that technology has on their teaching and how they present the subject matter by using of technology in the classroom (Koehler & Mishra, 2009).

The framework can also be combined by using TK with PK to form the technological pedagogical knowledge (TPK) (Koehler & Mishra, 2009). This concept requires that teachers use the various pedagogical designs for their content and combine it with technology to create experiences for students to understand the material. The TPK concept shows that teachers can use technology in ways that are appropriate for their pedagogical style (Koehler & Mishra, 2009).

The TPACK framework was created through the combination of technology, pedagogical, and content knowledge (Graham et al., 2012). The TPACK main objective is looking at how teachers are incorporating and integrating technology into their lessons using the knowledge they have acquired throughout their studies in content knowledge and teacher preparation (Swallow & Olofson, 2017). Figure 1 shows how each of the domains line up to create synergy and shows how each influence how they work together to help teachers create connectivity in the classroom.

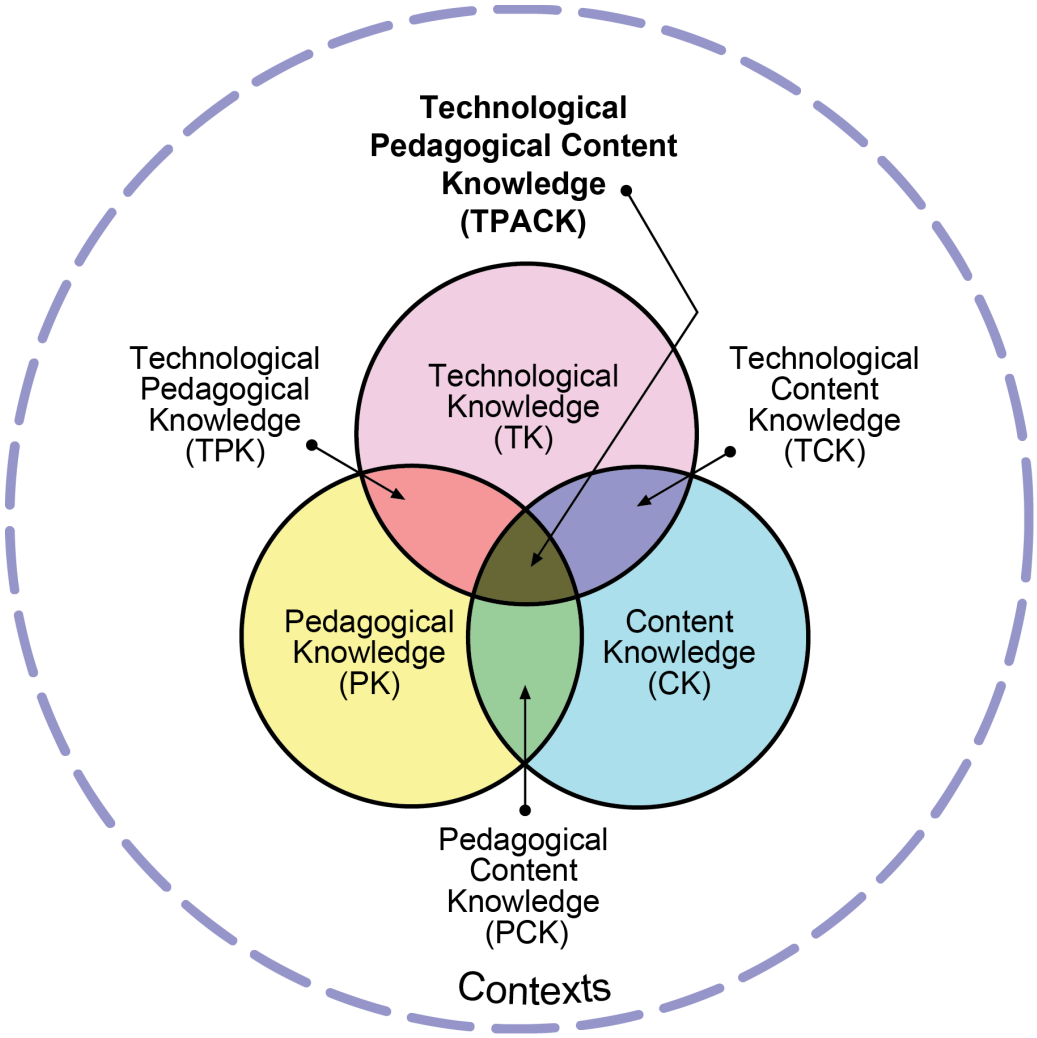


Figure 1. The seven components of Technological Pedagogical Content Knowledge (TPACK). Reprinted from *Using the TPACK image*, 2012, Retrieved July 20, 2021, from http://tpack.org. Copyright 2012 by Koehler. Reprinted with permission.

Integration of technology into the classroom requires that a teacher has information and communication technologies (ICT)-integrated lesson strategies that rely upon the teachers to use TK, PK, and CK as their main source of technology integration (Koh & Chai, 2016). Teachers use years of professional practice as experience to influence what they are willing to change in the pedagogy when adopting a new ICT in their classroom. TPACK programs help teachers to

develop and better support their technology integration into the classroom pedagogy (Koh & Chai, 2016).

Blended learning has a minimum amount of technology knowledge that is needed to successfully implement resources in the classroom. Past studies of TPACK have shown having a high motivation and understanding of technology helps integrate new pedagogy that involves ICT to integrate lesson design (Koh & Chai, 2016). Teachers use the technology they understand, have the best knowledge about, and have the most confidence to use in a classroom setting to instruct their students in the best way possible (Koh & Chai, 2016). The introduction of new technology in the classroom can create resistance from teachers' because of those who are not comfortable using the technology (Jeong et al., 2016).

The direction that education is heading in the 21st-century is for classrooms to have a virtual component (Koh & Chai, 2016). This makes understanding technology important for both teachers and students in a blended learning environment to be able to learn and teach concepts. This will allow for better integration of sociocultural, cognitive, metacognitive, productive, and technological competencies that will be needed in a society that is being transformed by technology. This requires that students be able to work collaboratively and have real-world problem-solving skills to function in the 21st-century workplace. It is important for students to understand information and communication technologies (ICT) in the classroom. Understanding this skill allows teachers to draw upon their knowledge about using both technological knowledge and knowledge about the content to helping them to understand any problems about a concept (Koh & Chai, 2016). This is an example of how teachers might use their TPACK knowledge to advance instruction through their pedagogy in their classroom helping for it to be integrated into the classroom.

Teachers may be on one of three different levels of TPACK when integrating technology in the classroom, which includes initial TPACK, TK/TPK, and refined TPACK (Koh & Chai, 2016). Integration of technology into the classroom is done through modeling. Technology is not a one-size-fits-all because every teacher has a different approach to how they instruct their students, and each teacher is on a different level of technology usage with may be barriers to adoption (Koh & Chai, 2016). Teachers who have knowledge about their TPACK aids in the effective adoption of technology into the classroom, which allows teachers to know what technology to use to supplement their teaching practices. The technology which is supplemented into the classroom can enhance their pedagogy and help to create a student-centered learning environment.

Related Literature

Blended Learning

Pinto-Llorente et al. (2017) defined blended learning as a blend of traditional archetypal learning environments that have been around for centuries using traditional face-to-face instruction combined with distributed learning environments that have begun to grow with technology. According to Hrastinski (2019) blended learning is a learning experience that uses a combination of both face-to-face and online instruction that allows for instruction to take place while in a classroom environment. The development of information and communication technology (ICT) helped to create structure for a blended learning environment. The combination of both face-to-face and online instruction allows blended learning to also be called hybrid learning or mixed-mode instruction (Lu et al., 2018). Hrastinski (2019) says that blended learning is a mixture of learning from face-to-face instruction, a mixture of instructional modalities, and a mixture of instructional methods. These methods allow for a blend of

instruction from traditional methods and have a mix of delivery methods that allow for mixing and changes to pedagogy to instruct students in the content being delivered.

Blended learning environments allow for students to have the ability to learn the material at their own pace because of the technological aspect of students having access to the material in a digital format. This gives students multiple chances to do activities to reflect on concepts that are giving them trouble to use videos or notes to help them grasp the concept (Martínez et al., 2020). This makes blended learning different from face-to-face learning or autonomous self-directed learning because blended learning allows for both a virtual aspect and a social aspect helping to drive the construction of a blended classroom by having aspects of both to help drive the learning (Martínez et al., 2020).

Blended classrooms have several different forms in which they can address both the virtual and face-to-face aspects of a classroom. A flipped classroom is a blended classroom because students are learning in both in a traditional classroom setting like face-to-face only allows for working on material and an interactive setting provides the classroom instruction to the students (Van Leeuwen, 2018). Students get the instruction through videos while in their home setting in a flipped classroom which have a specific design being different from a traditional classroom setting. Students need time to learn how to use digital devices and pace themselves when using strategies associated with digital learning because of the differences from a face-to-face learning environment. There is less content presented through face-to-face instruction than in a blended learning environment since the information is presented through videos and other resources (Van Leeuwen, 2018).

The use of mobile technology such as Chromebooks, tablets, and smart devices allows for mobile learning to take place both in the classroom and at home for instructional activities.

Van Leeuwen (2018) said instructional conditions in blended learning can take many forms but the choice of how to conduct a blended environment depends on how it aligns with the district goals. Phillips et al. (2016) mentioned a blended learning environment allowing learning objectives to be accessible and flexible to mirror the traditional model. The hope is that blended learning will facilitate higher levels of learning through both independent and collaborative learning experiences (Phillips et al., 2016). Successful collaborative experiences are accomplished when the teacher and group members use quality approaches to setup the group and blended learning experience (Ellis & Ellis, 2016). This implies that the design and how the instruction is taught, along with follow-up instruction, are contributing factors in student success when using information and communication technologies (Ellis & Ellis, 2016).

Blended learning presents a big change from the way teachers have traditionally taught their lessons to one that combines technology with face-to-face instruction (Van Leeuwen, 2018). The pedagogy that is involved in creating a digital classroom needs to integrate instructional pacing and sequence, which can help increase student engagement in a different setting and help keep them on task during the times they study the content (Borba et al., 2016). Students prefer an enhanced learning experience that uses technology as opposed to a traditional classroom. This can present challenges to teachers who have low digital literacy, and more technology is integrated classroom to enhance the learning experience for students (Borba et al., 2016).

The educational environment has changed because of the development of technology that is engaging for students to use and learn content in the classroom (Subramaniam et al., 2019). The introduction of mobile devices in the classroom created the opportunity for a blended classroom to be a viable option for today. Using mobile devices in the classroom establishes the

potential benefits of mobile learning because teachers can teach remotely and not use a traditional setting. The important aspect is that when teachers do start into blended learning is to establish the design as a framework for instruction and pedagogy to be a successful learning model (Barreh & Abas, 2015).

Classroom Interaction

The use of various types of mobile technology in the classroom allows for the possibility of expanding the classroom beyond the traditional walls, allowing mathematics instruction to be taught anywhere a device has access to the internet (Borba et al., 2016). Blended learning allows students, especially in secondary school, to be treated like adults because of the ability to ask questions and work at their own pace. This allows teachers to have the ability to work with students when they need assistance right away because of access to the teacher.

Blended learning environments can use many different approaches to teach which can include an asynchronous model and flipped classrooms to help students get access to the content. This gives students to have content presented both digital, paper, and in person to learn the content and interact with the instructor as needed (Borba et al., 2016). The learning could also be synchronous where the instructor teaches content at a set time and students participate during the lesson by asking questions as needed. Both asynchronous and synchronous options in a blended classroom have students coming into a face-to-face environment receiving work and further instruction on the content being presented. This allows students to have options and furnishing them with control over their learning experience. This leads to learner satisfaction in the educational environment.

Student Learning Achievement

Student achievement is important regardless of the environment in which a student is conducting their learning experience. Blended learning classrooms use the medium of multiple different devices, which could include a computer, Chromebooks, tablets, phones, and any new tool that can be used to power the motivation of the student's interest in learning (Bray & Tangney, 2016). The goal in blended and online learning is to provide an environment that will allow students to grasp concepts that gives them a choice in the setting to learn the material. The flexibility of learning in a blended environment allows student performance to be influenced based upon the learning style (Thai et al., 2020). This allowance of learning both in a setting chosen and at any time by the students allows them to have some choice in their learning style. Students can watch videos to understand the material rewind, find different videos, and use multiple tools to help them to understand concepts that are being taught (Thai et al., 2020). This allows students to feel motivated in learning and have control in a blended learning or virtual experience.

Blended Learning Environment

The concept for a blended learning environment began before the technology we have today was ever in use in the classroom. Benjamin Bloom studied three different learning styles back in 1984 (Nickels & Gartner, 2018). The three groups Bloom was studying were traditional whole-group instruction, whole-group instruction that incorporated formative assessments and feedback with parallel assessments to show mastery, and small-group tutoring (Nickels & Gartner, 2018). The surprise results of the study showed that the students that were in the small-group tutoring outperformed the other two groups by 98%. These results allowed the concept of the principles that are used in blended learning to begin in classroom instruction adapting to incorporate technology that we use today.

The blended learning model used today can include a mixture of both face-to-face learning and online learning through the means of devices that connect to the internet (Nickels & Gartner, 2018). The development of virtual learning environments has seen improvements since the technology in the classroom enhances social interactions and the collaborative knowledge that can be used online settings (Martínez et al., 2020). Blended learning involves replacing traditional face-to-face teaching methods in a classroom through the integration of technology by allowing a teacher to design the lessons with the available technology. This can be different from classroom to classroom depending on the subjects that are taught.

Blended learning requires certain conditions to be implemented effectively into online learning environments such as student engagement, activates prior knowledge, and defines learning objectives for the instruction that takes place (Nickels & Gartner, 2018). In addition, there must be trained instructors to help teachers integrate technology pedagogy to be effective while using it in mathematics classrooms (Martínez et al., 2020). Once teachers have planned the implementation of the technology that enhances blended learning. It is important that they look at student learning outcomes and seek ways to improve instruction (Nayar & Koul, 2020). This process will help in the successful integration of technology into the classroom and each time new technology is introduced in classroom it should be evaluated every time new content is taught.

Mobile Learning in the Blended Classroom

The blended classroom is a classroom that moves away from the traditional classroom to set up an environment for active learners. This allows students to learn and study by viewing previous lessons or upcoming lessons allowing them to receive instruction on their time (Phillips et al., 2016). The goal is to have a positive perception from individuals in using the tools for a

blended classroom, so they enjoy the activities that are a part of the lessons and increase their interest in the content they are learning (Boshoff & Laher, 2017). The way technology is introduced into the classroom is not a one-size-fits-all approach because of the technology abilities of each of the teachers and the teachers' pedagogy needs to be explored to see how it will enhance their classroom instruction (Martínez et al., 2020).

The use of technology in the classroom allows for different approaches to a teachers' pedagogy which combines both face-to-face and online learning is becoming common practice in all levels of education (Borba et al., 2016). The blended learning classroom allows for an increased student agency allowing the student to both control their instructional pacing and sequence of doing tasks. This type of allowance in blended classrooms gives students a differentiated and adaptive learning environment helping students of all abilities. Teachers then have time to spend face-to-face with students in small groups helping and focusing on specific needs. This provides opportunities to do collaborative project-based activities, which would have been impossible in a traditional setting (Nickels & Gartner, 2018). Blended learning allows for opportunities to increase collaboration in the classroom and an increase in time-on-task. Increases in these two areas help to improve student performance because of how the lessons are presented digitally and can be viewed multiple times for understanding. This allows the students to be able to view them multiple times with fewer distractions than in a face-to-face classroom environment (Borba et al., 2016).

Whole-group discussions in a blended learning environment is method that can be used in the blended environment to help improve the learning process (Nickels & Gartner, 2018). The discussions allow for students to move from the digital platform that is being used in a mobile device environment and have human contact. Nayar and Koul (2020) suggest that there is a need

to include both the traditional methods of teaching with the digital tools. The evidence that using the blended learning tools are effective in learning but a student's soft skills such as interpersonal, communication, and team-working skills need to be acquired away from a screen (Nayar & Koul, 2020).

A type of blended learning is a flipped classroom which is perceived as a flexible classroom (Thai et al., 2020). Flipping the classroom experience is possible with technology because it allows a different experience than the traditional face-to-face classroom (Borba et al., 2016). Flipped classrooms are a form of blended learning that allows different ways for content to be presented to students with the use of technology. In a flipped classroom, students have a choice about where they want to learn, when they what to learn, and what they want to learn thus helping them to fell in control of their learning (Thai et al., 2020).

Flipped classrooms are one of the new-implemented strategies that, with proper guidance from teachers, can be a useful tool in students' learning and engagement in the classroom (Lin & Hwang, 2018). Wang et al. (2019) mentioned the essence of a flipped classroom is moving the delivery of content outside the classroom. This requires that students already have a basic understanding of the content before coming to class to participate in the activities that will be used to engage students. When this condition is met it allows for the learning environment to be a student-centered and teacher-centered classroom helping to have class time available for interacting learning activities (Wang et al., 2019).

The concept of using a flipped classroom is to give students control of their learning by changing the way content is delivered instead of the way it is normally taught in a traditional school building. With the use of technology and mobile learning, students learn their material anytime and anywhere in the world (Parajuli, 2016). This means that students are having to

change their study strategies. The idea behind a flipped classroom is that students learn the content outside the classroom through watching videos, using extensive notes, and other means of instruction before coming to the classroom (Lin & Hwang, 2018; Wang et al., 2019). The affordances of digital technology have allowed teachers the ability to work problems out and send them to the entire class through screenshots, giving students a wide range of content to use while learning the material at home (Muir & Geiger, 2016).

Learning the material at home allows teachers the ability to do multiple different activities during the school day (Muir & Geiger, 2016). Doing this allows the teacher to focus on what would have been homework during the school day and this allows students to have access to the teacher when practicing the material (Lin & Hwang, 2018). Students hold a positive view on using a flipped classroom vs a traditional classroom experience, but experiences can be different depending on the model of the classroom used (Wang et al., 2019). Flipped classrooms require that teachers be intentional about the content students receive, ensuring that they are providing the best possible resources to the students (Muir & Geiger, 2016).

Students and Teachers Attitude Toward Blended Learning

Attitudes and perceptions toward technology are important when trying to understand how individuals will react to technology (Boshoff & Laher, 2017). Rogers' Diffusion of Innovations Theory suggests that there are five steps of technological innovations, which could have an impact on perceptions toward a group like a blended classroom because of attitudes (Boshoff & Laher, 2017). Teacher and student perceptions and attitudes toward technology and a blended classroom depend on if they are an early adopter or a late adopter of technology that is needed to have a mobile learning environment (Boshoff & Laher, 2017).

Student Perceptions and Attitudes of Mobile Learning

Students prefer to use technology in the classroom because they feel connected to the digital technology. This is because they have access to resources that can provide help to learning concepts (Borba et al., 2016). Learning mathematics through mobile devices has been shown to change students' attitudes toward mathematics because they have a positive experience with using mobile technology (Willacy & Calder, 2017). Mobile technology helps students to feel challenged and that they are learning through challenging games and a willingness to take risks when learning new concepts (Willacy & Calder, 2017). This allows students to take a self-directed learning approach, which allows them to take ownership in their learning and helps them to succeed, which is an important 21st skill (Bartholomew et al., 2017). Students today feel connected with technology because it has been a part of their lives from the start. By using technology, they feel confident in learning, which helps them to be engaged in classroom discussions (Bartholomew et al., 2017).

In a blended learning environment, students feel that they have greater autonomy to be able to set their own pace of study according to Pinto-Llorente et al. (2017). The students' high level of satisfaction by using a blended learning environment allows for flexibility to learn concepts, use different instructional resources, and helping them learn concepts in a vastly different approach than in a traditional method. Moving to a different mode of learning takes motivation to learn the technology-enhanced ways of learning for students and following the teacher expectations from working in a traditional method and an online method of learning trying to increase students' self-efficacy (Van Leeuwen, 2018).

Technology in the classroom provides challenges for students who have difficulty using the tools provided beyond just motivation that can impact a students' experience. Students who have trouble using technology intended for use in the classroom settings are subject to have a

negative experience using these applications. This negative perception that students have toward using technology in the classroom and the use of educational applications complicate the process in teaching students (Heflin et al., 2017). Teachers are looking for strategies to help them increase student achievement. This means teachers use measures to help in collaboration and engagement are used in helping students to get involved in the learning process and create a positive perception of using technology (Heflin et al., 2017; Pinto-Llorente et al., 2017). The use of response systems and accountability measures like written responses in groups helps to improve students' perceptions of learning by providing quick data for assessments and engagement while in collaborative time. This allows teachers to improve the educational experience while teaching content to students by using technology to build student independence, engagement, and communication (Heflin et al., 2017).

Teacher Perceptions and Attitudes of Blended Learning

Teachers' beliefs are important to how they conduct their classroom environment (Edannur & Marie, 2017). Teachers with low digital literacy do have problems implementing technology into the classroom, which is a prerequisite to blended learning (Borba et al., 2016). Teachers' perceptions are essential to how successful technology enters into their classroom (Edannur & Marie, 2017). The use of mobile devices in the classroom can create an environment that helps students to learn content making the integration an easy fit into a teachers' pedagogy (Bartholomew et al., 2017).

Teachers believe that when integration of these devices occur in their classrooms, they need to understand how to use the technology. This is so they can monitor students to ensure they are staying on task with the activities they are given so learning is taking place (Bartholomew et al., 2017). The in-service teacher who uses technology in the classroom feels

like they are at a disadvantage because of how fast technology is changing in the education field (Daher & Baya'a, 2014). Even with the constant change in technology implementing it in a blended learning environment can be achieved through assistance and professional development in workshops helping them to integrate technology into their pedagogy (Borba et al., 2016).

Daher and Baya'a (2014) point out that pre-service teachers are keeping up to date on new technology when they are studying and are willing to integrate technology into their classrooms (Daher & Baya'a, 2014). Pre-service teachers are not invested in a traditional pedagogy that does not involve technology because they are used to using technology in the classroom and they are taught on the newest technology. Teachers' with years of experience need to change their style of pedagogy to implement newer technology into their lesson plan design, which they are not as willing to do (Daher & Baya'a, 2014). In addition, pre-service teachers have typically been exposed to technology their entire life and are familiar with it more than using traditional teaching methods (Daher & Baya'a, 2014). Abidin et al. (2017) suggest that it is important that teachers enhance their knowledge of technology, which helps them to be able to use technology effectively in the classroom to enhance instruction. The problem with teachers not understanding the technology is a reason why teacher attitudes are low, with in-service teachers implementing technology into their classrooms and bridging the gap by implementing technology into their classrooms, which happens with professional development (Abidin et al., 2017).

Professional development activities are necessary for teachers to understand how to integrate technology into the classroom (Daher & Baya'a, 2014). The constant change in how technology is advancing in education means that teachers need to have training opportunities to help them to feel confident in including them in the classroom (Daher & Baya'a, 2014).

Teachers' attitudes are different if they have the correct amount of training to increase their experience using the various devices and software that are available to be used in the classroom (Daher & Baya'a, 2014). The pre-service teachers who come into the field have the experience with the new technology, but after a few years of being in the classroom lose their edge because of the constant advancement and software changes (Daher & Baya'a, 2014). Using this effectively in the classroom can have profound implications in the classroom, including increased engagement in classroom activities (Bray & Tangney, 2016). Teachers need to portray confidence in using the devices and knowledge of the devices in the classroom so they can be used effectively and help to engage students learning mathematics.

Mobile Technology in the Classroom

Mobile technology started as a research topic with the use of the Cornell Plantations projects (Parsons, 2014). The popularity of mobile devices since that time has been steadily increasing over the past years, which in turn has started to change the classroom environment (Xue et al., 2018). The first research was completed with portable devices and not the mobile devices considered today (Parsons, 2014). The technology that is used in today's classrooms include mobile phones and tablet computers, which are drastically different than personal computers a decade ago (Xue et al., 2018). There have been many advantages of mobile learning that make the inclusion of them into the classroom desirable to many classroom teachers. Two of these advantages are the ease of use for teachers and students, and the flexibility of being used for classroom activities in working problems in the mathematics classroom (Xue et al., 2018). The advantages of using mobile technology in the classroom come at the cost of a steep learning curve for some teachers (Phillips et al., 2016). The time spent creating lessons should decrease over time, allowing for teachers to devote time to other activities in the classroom.

The access to mobile technology in the classroom allows teachers and students to interact with lessons in a different way allowing for new active learning activities (Foldnes, 2016). Students can obtain knowledge through the transmission of content through videos students watch outside the classroom. Using mobile technology while teaching allows for teachers to use cooperative learning activities in the classroom using it to develop students' motivation for learning in a cooperative setting (Foldnes, 2016).

A flipped classroom uses a lot of mobile technology requiring teachers to use web-based materials to supplement the actual face-to-face lessons, which take place in a traditional classroom. The use of presentation slides and other resources do help students learn but it is suggested that teachers only use virtual recordings to supplement lessons and not use them as the only lesson that students receive (Thai et al., 2020). Edannur and Marie, (2017) state that teachers who have student-centered beliefs tend to be successful regardless of technology, administrative, or assessment barriers. The importance is having support to influence technology integration decisions in the classroom all while making sure that teachers believe that mobile technology will help their pedagogy in teaching students (Edannur & Marie, 2017).

Mobile technology in the mathematics classroom can consist of a variety of different mediums, which can include classroom videos, instructional videos, animations, simulations, and games (Borba et al., 2016). This allows students to mashup their learning environment called *"frankensteining"* by developing their individualized technological framework to allow them to learn at their own pace (Borba et al., 2016). Each of these is different and allows students to gain experience by using different ways of learning problems to help in their memory. This helps to alleviate the inflexibility of traditional learning and exploring different ways of solving problems that are not entirely focused on traditional paper and pencil methods (Pinto-Llorente et al., 2017).

Technology Changes in the 21st Century

The National Policy on Education states the strength of the educational system is dependent on the quality of teachers, which is why teachers must become familiar with technology use in the classroom (Shulman, 1986; Edannur & Marie, 2017). The use of technology in the 21st century has seen multiple changes in how teachers use technology in their daily lessons. The growth of the faster internet is allowing for a deconstructing of the idea of a traditional classroom and transforming it into a digital classroom (Borba et al., 2016). The growth of mobile learning in the classroom is dependent on the number of teachers who use technology for teaching and learning (Parajuli, 2016). Teachers use technology to increase interaction in the classroom, helping to orchestrate influences for different scenarios that allow for engagement (Onyema & Daniil, 2017). The use of mobile devices in the classroom is considered an unwanted distraction, which takes many forms, from computers to calculators and mobile devices (Onyema & Daniil, 2017). The use of mobile devices in the classroom environment should first consider how it would affect the student and the teacher (Onyema & Daniil, 2017).

The use of mobile technology in the classroom has changed many times, from using a single computer in the classroom to now using tablets, mobile phones, and Chromebooks. These devices each require teachers to obtain technical support and training to develop specific technology integration into the classroom to be adapted to a blended learning environment (Edannur & Marie, 2017). In addition, to training each time a new device is explored, research from projects, journal articles, and recent innovations must be considered before implementation into the classroom. It is not enough to just integrate new technology into the classroom and move to a nontraditional classroom but to consider the relationship between the pedagogy and content

(Limniou et al., 2018). The teacher has so many options to look at that they must consider what is best for their classroom environment to help them demonstrate the content to the learners to grab their interest (Parsons, 2014).

Teachers need to have a general understanding of TPACK and have training on the programs to effectively use it in the classroom (Graham et al., 2012). This will help them teach curricular knowledge to the students that blend a traditional approach with technology integration (Graham et al., 2012). The goal of integrating technology in the classroom is to help engage students regardless of the teaching environment and helping them to understand the content being taught to develop higher-order skills (Graham et al., 2012; Limniou et al., 2018). This can deal with both the affordances and constraints that technology brings as it becomes available for classroom use by helping teachers feel confident in using technology in the classroom (Graham et al., 2012).

Mobile Learning Applications for Blended Learning

An Analysis of multiple research studies indicates that there is much strength in mobile learning and its applications. Mobile learning has been shown to increase engagement in the classroom, which helps with increased collaboration in the classroom setting (Bray & Tangney, 2016; Fabian et al., 2018). Even though multiple students have shown increased learning there are still weaknesses that are apparent that studies have shown, which prove that even though the technology is useful in the classroom the results are not always positive (Fabian et al., 2018; Mcgloinet et al., 2017). The problem is that research does not keep up with the development of digital technology in mathematics education (Borba et al., 2016).

The changes in pedagogy in mathematics could include using digital technology like streaming videos, and any resource that allows for access to knowledge (Borba et al., 2016).

These different kinds of tools can help to foster many skills needed in a digital society such as increasing communication skills, enhancing creativity, and increasing literacy (Nayar & Koul, 2020). Therefore, giving the student access to these resources allows them to participate on their own time and learn at their own pace instead of a traditional model of learning (Borba et al., 2016). Limniou et al. (2018) the unknown is how a teachers' influence will evolve because of the influence of technology but integration does require teachers to facilitate discussions when students are involved in working on the different applications.

Mobile Technology in Mathematics

Mathematics is one content area that has utilized mobile technology for years with the use of calculators (Borba et al., 2016). In recent years, the hand-held calculator has been redesigned into a mobile application that can be downloaded to phones, computers, and Chromebooks. In the mathematics classroom, an application that is changing the way students rely upon calculators is the DESMOS calculator. This is because DESMOS can be a calculator that is downloaded on all mobile technology devices. The use of mobile technology in the mathematics classroom has changed many times, starting with a four-function calculator to now using mobile devices that use applications like DESMOS to solve problems. The DESMOS application allows for students to gain instant electronic feedback that will help students adjust their answers on their next attempt, a process called iterative feedback (Danielson & Meyer, 2016). Each time a new device is added, the implementation of how it will change the classroom and increase their intellectual risks in mathematics should be explored (Danielson & Meyer, 2016). The amount of different technology devices available to teachers make it challenging for teachers to consider what is best for their classroom and students (Parsons, 2014). Teachers need to have training on the programs to effectively use the applications in the classroom and help

them teach curricular knowledge to their students (Graham et al., 2012). Each individual application needs to be evaluated to understand how they will impact the curriculum and pedagogy. The goal is to help teachers in the integration of appropriate technology that will help to engage students and help them understand the content being taught (Graham et al., 2012).

The advantages of using the DESMOS calculator as opposed to a traditional calculator are the ease of use and flexibility when using them in classroom activities because it is on a mobile device (Xue et al., 2018). Schools where students have access to Chromebooks, all students will have access to the same model calculator, which allows for teachers to integrate the application into their lesson plans based on the various opportunities offered by the DESMOS application. The DESMOS application allows teachers to develop assignments and activities to increase the engagement of students in lessons and this helps teachers to get descriptive feedback to help students to succeed on material being taught (Danielson & Meyer, 2016). This allows for ICT lesson strategies that will engage the classroom in learning specific content in daily lessons.

Massive Open Online Courses

Digital resources are available to students to help them learn content through Massive Open Online Courses (MOOCs) these classes have content and teach content through videos and access student knowledge through online assessments (Conijn et al., 2018; Nayar & Koul, 2020). MOOCs used as part of face-to-face instruction are being used in blended learning designs to enhance student learning by furthering the quality of education by having the ability to give personalized learning (Feitosa de Moura et al., 2021). MOOCs have the benefit of allowing the teacher to assign the entire class content and allowing students to work at their own pace. This allows the teacher to walk around answering student questions and giving more one-on-one

attention than in a traditional setting (Conijn et al., 2018). Teachers can predict student performance based upon their MOOC activity by using the course evaluations.

MOOCs became popular through the start of Khan Academy (Nayar & Koul, 2020). Khan Academy is a website with resources and online tools, which can be fully personalized for students. This is a way that help teachers to identify student achievement gaps on specific strands of material that has been covered. Khan Academy has students work problems to figure out their skill level then place them in the appropriate level based upon the students' current skills. Once a students' skill level is knowledge, Khan Academy instructs students though the use of instructional videos, which then allows students to learn at their own pace to strengthen the weakness in specific areas (see https://khanacademy.org). Another resource is Purple Math, which only has instructional content in the form of lessons that gives students a model and directions to solve problems by finding looking at specific strands of content (see https://purplemath.com).

MOOCs like Khan Academy and Purple Math strengthen student skills on specific stands of content to help them to be successful in their studies. The resources are generally good to use with students because they tend to have a positive attitude toward learning on mobile devices (Feitosa de Moura et al., 2021). Each MOOCs used in the classroom have their own degree of success in helping students learn content in a blended learning environment.

Strengths of Mobile Learning

Increased Engagement

Mobile learning in the classroom is learning using various means like electronic devices, videos, and discussions on various platforms (Borba et al., 2016). The use of mobile devices in the classroom can facilitate increased engagement of students in the classroom in mathematics

(Bray & Tangney, 2016). Learning is not restricted to just the traditional methods. Students who learn in a nontraditional classroom can access information by using multiple resources (Subramaniam et al., 2019). The positive engagement and attitudes students have toward mathematics increase, helping them to develop a sense of ownership and autonomy in their learning (Bray & Tangney, 2016). This is due to the increased confidence students have toward their positive experience in understanding the material because they have ownership (Bray & Tangney, 2016). This allows them to develop skills as team leaders in groups allowing them to solve problems, which helps the development of confidence in the subject (Subramaniam et al., 2019).

Increasing student's confidence in mathematics is important (Fabian et al., 2018). The use of technology allows for them to have confidence learning the material because many ways help them to learn (Fabian et al., 2018). This creates an active learning approach that helps students to be engaged in the learning process (Subramaniam et al., 2019). Students have access to a wide range of mediums that can include watching videos, access activities, and access animation that allows them to understand topics better (Fabian et al., 2018). Teachers pedagogy has shifted from a traditional setting to one which uses a student-centered approach. This allows students a chance to be motivated to learn the material through devices instead of the traditional setting of a teacher in the classroom (Hwang et al., 2018).

Students today are considered digital learners because they have grown up around technology since birth (Mcgloinet et al., 2017). Mobile learning allows students to have an opportunity to learn in the classroom with a variety of different strategies by devices that can accommodate different learning styles (Hwang et al., 2018). Mobile learning allows students to have an active role in the learning process through many different avenues of learning (Parajuli,

2016). Using these programs allows teachers to send different types of supplemental materials to students to help them to achieve mastery. This shows that students are understanding the content because they are receiving supplementary materials to help keep them interested in learning and they are tailored toward the specific needs for each student (Mcgloinet et al., 2017).

The use of technology helps most students have positive emotions, experiences, and perceptions towards learning with mobile devices and in a blended learning classroom (Jeong et al., 2016). The blended learning environment uses mobile learning devices to create an environment that allows for creativity. This helps in giving students enthusiasm in working in the classroom because they feel empowered by freedom of choice in their learning experience. This is considered a relationship revolution with technology (Borba et al., 2016).

Collaboration

The increased acceptance and usage of technology by schools and local governments has allowed for technology to be in the school more than before, which allows for increased usage and collaboration (Fabian et al., 2018). The goal is to create strategies in the pedagogy that allows for content to be taught using multiple connections by teacher experience to allow for vertical ideas to be developed (Borba et al., 2016). The importance of this is to create a pedagogical design in which each classroom teacher can successfully integrate technology in the classroom and use educational content with technology in the classroom (Fabian et al., 2018).

Integration of technology allows for advantages in the learning environments in ways that traditional environments currently do not have access to education (Fabian et al., 2018). Hwang and Lai (2017) showed that the use of mobile devices helped to improve students' learning achievement and self-efficacy. This is through meaningful discussions about the content in the

classroom and gives teachers time to help students who do not understand the topic (Hwang & Lai, 2017). Teachers need to be involved in the discussion process during face-to-face instruction of students even though instruction is taking place in a technology-enriched classroom to give students the direction and examples. This helps to increase the satisfaction of students while learning the content in a blended learning environment by giving students multiple avenues to learn material (Limniou et al., 2018). The objective is to create activities that allows students to engage and collaborate to create learning experience (Heflin et al., 2017).

Blended learning classes use video lessons that are appealing to students to teach content in a different setting, these either teacher made or videos that have been made by others. Teachers use these videos to allow more time in activities during traditional face-to-face instructional time to giving students more attention and expand on the content covered allowing for better understanding of content (Jeong et al., 2016). This gives students control over what is learned based upon the variety of possibilities available to students and the mashup of the services that students can choose both in their virtual time and face-to-face time in the classroom portion of learning (Borba et al., 2016).

Technology can also enhance collaboration by helping to develop a pre-defined group of learners instead of the teacher developing the groups (Jeong et al., 2016). Using technology this way helps teachers to devote time to interact with students by knowing what content students need to work on in class. This also increases the amount of time teachers have because they do not have to arrange students by hand calculating data, which gives them more time to interact with students, cover content, and prepare lessons (Borba et al., 2016). Teachers using the extra time created by not introducing material in the class for the first time can observe students working, address their concerns, and present clarifications to problems in real time as they are

happening while they are working in the classroom (Jeong et al., 2016). Extra time in the classroom creates more time for learning to be experiential and allowing for the development of innovation and critical thinking skills by letting the student be the center of the learning (Nayar & Koul, 2020)

Weakness of Mobile learning

Mobile technology has had a lot of positive research studies that have shown where it could be useful in the classroom, but there are negative aspects of using the devices as well (Fabian et al., 2018). Studies have shown that technology use in the short term has shown positive results but after the novelty has worn off there is a decline in test scores (Fabian et al., 2018). Marco et al. (2017) suggested that students are motivated to learn concepts using mobile technology, but at times students have shown they are distracted from learning. This point means that teachers must understand their pedagogical knowledge to ensure that students are using the technology in the classroom effectively (McMullen et al., 2019). Teachers need to realize that it is not just the technology that causes students to learn, it is the pedagogy that they use through using technology in the classroom that has an impact on student learning (McMullen et al., 2019).

Perry and Steck (2015) stated that teachers need to gain experience using mobile applications for them to be effective for classroom use. The reason behind using technology in the classroom is to help students become successful in learning the content. The problem happens when teachers have trouble with the software; there is downtime in the classroom, which would not happen in a traditional classroom setting (Perry & Steck, 2015). Willacy and Calder (2017) found that it's not only important for teachers to know the applications that the students use, but also to find the right application for students because not every student will

respond the same to each application. Students need to feel that the application they are using is giving them a positive experience for them to change their attitudes toward learning mathematics through the use of mobile technology (Willacy & Calder, 2017).

Using mobile devices in the classroom in groups still relies on a teachers' belief about the effectiveness of groups. Knowing that not every application will be effective for all students as mentioned by Willacy and Calder (2017) using technology in groups will have a similar effect. Heflin et al. (2017) mentioned that teachers need to educate students on the responsibility of how to conduct themselves in groups to help them to be effective in collaborative learning environments. The goal is to motivate students by showing them how to use their mobile devices effectively in a digital setting and creating a positive experience with the use of technology help.

The use of technology in a collaborative environment allows for another avenue for students to go into disengagement from the group when they feel like they are not needed or disinterested in the discussion about the content (Heflin et al., 2017). Helping in these issues, the teachers must understand the integration process of the technology into the classroom and have support in placing it in the classroom. Teachers who lack motivation and support might not obtain the same outcome as teachers who implement the tools effectively. This could over time lower the motivation of using technology in the classroom; making them reluctant to change when new technology is introduced (Nayar & Koul, 2020)

Fear in using mobile technology is another weakness that could impact students and attitudes when implementing technology into the classroom (Emelyanova & Voronina, 2017). This problem may be anxiety or negative experiences using computers in which these students prefer using a traditional method of teaching. Students who have negative emotions or attitudes towards a blended learning environment have lower scores than students who have a higher

attitude toward the way of instruction (Jeong et al., 2016). A phobia that extends toward technology may carry over to the learning process if that is the only way content is delivered, which is another reason why face-to-face instruction is needed in a classroom (Emelyanova & Voronina, 2017).

Summary

Blended Learning has increased significantly in the 21st century and this has created a new type of learning environment for both students and teachers (Bray & Tangney, 2016). The primary objective in education is for students to learn the content so they can use it later on in life. This has caused teachers to change their teaching styles and begin to use mobile devices to keep students engaged in the classroom (Bray & Tangney, 2016). This has the potential to help students to be confident in learning mathematics through participation instead of it just meeting a requirement (Bray & Tangney, 2016). Studies have shown that an increase in teachers' attitudes has helped to increase the use of mobile technology in the classroom (Abidin et al., 2017).

Mobile learning in the classroom can increase the way students learn and help them to have meaningful learning (Bray & Tangney, 2016). This can help students want to learn mathematics when they would otherwise feel like they do not need to learn mathematics for their future careers (Perry & Steck, 2015). This can help students to be successful with mathematics because they are not being forced to learn but feel like they are learning what they are enjoying. Positive results are students who change their attitudes towards learning, and are interested in learning using a blended environment because they are interested in using mobile devices in the classroom (McMullen et al., 2019).

Teachers who decide to integrate blended learning into the classroom need to consider their TPACK knowledge to help them to increase successful engagement with their students.

Teachers who are confident in integrating technology into their pedagogy and know-how to run the applications have better results and increased student engagement in the classroom. Doing this will allow for a successful transition from a traditional classroom to a mobile learning classroom that can support a blended environment (Limniou et al., 2018). When teaching in a blended learning environment it is important to use the right technology and applications for the content area being taught. This helps to ensure that content is delivered in a way students understand and help to feel positive about learning.

The overall objective of a blended learning environment uses both face-to-face and technology to provide students with an individualized learning experience and understanding of the concepts (Nickels & Gartner, 2018). This allows for students to feel positive about their learning experience helping them to be motivated to learn because they have a feeling of control over their learning (Thai et al., 2020). This happens by giving students control through multiple avenues to help teachers to understand student performance by assessments, performance on MOOCs, and the amount of time digital media is used (Conijn et al., 2018). This helps to set students up for working in the 21st century by building up their skills and knowledge in the digital age by transforming their learning from a traditional classroom (Onyema & Daniil, 2017; Orlando & Attard, 2016).

CHAPTER THREE: METHODS

Overview

This quantitative, correlational research study seeks to determine if teachers' perceptions toward a blended classroom learning environment influence student achievement on their benchmark tests in a Virginia middle school in one southwestern district. A correlational research design was used for this study to help explore the difference in a blended learning environment between teacher perceptions of design dispositions, lesson design practices, and their technological pedagogical content knowledge, with student achievement on the second nine weeks benchmark in mathematics. This chapter will explore the methodology that was used in the research to provide data about understanding how teacher's perceptions toward the blended classroom affects student achievement on their benchmarks. The information provided in this chapter will give essential components used in understanding the study. It will discuss the research design, research question and state the null hypothesis of this study. Then the chapter will cover the participants, the settings, the instruments, and the procedures involved in conducting the study. Finally, the data analysis of the study will be presented at the conclusion.

Design

This research study used a non-experimental, quantitative correlational research design, which matched a teacher survey scores with classroom averages of students' second nine weeks benchmark the results. Gall et al. (2007) described the correlational design as a research method to discover the relationship among variables. This study used the technological pedagogical content knowledge (TPACK) survey designed by Koh et al. (2015) to determine teachers' lesson design practices, and their TPACK, design dispositions (DD), and lesson design practices (LDP)

to determine if there is a relationship between teachers' perceptions and student achievement on the second nine weeks benchmark test.

The researcher studied how the independent variable of teacher perception, as reported on the TPACK survey, predicts student success on the second nine weeks benchmark test. The dependent variable is the students' scores on the second nine weeks benchmark test. This allowed the researcher to see how teachers' perceptions of various TPACK, DD, and LDP dimensions relate to student benchmark achievement in a blended learning environment.

The school being studied shifted to a blended education setting at the beginning of the 2020-2021 school year after a brief introduction to using a remote model in the fourth quarter of the 2019-2020 school year. The researcher seeks to understand teachers' perceptions of a blended classroom and their TPACK score to show the impact they have on student achievement in a blended learning environment. This data was used to determine the impact between teachers' perceptions and TPACK scores impacts the benchmark scores in middle school mathematics classes.

The students in each teacher's classroom had a variety of abilities, which was predetermined by the school guidance department based on the graduation needs of the students. The teachers' technology abilities was different as well but was assessed through the TPACK survey to have a clear understanding of their abilities, which include using Canvas, Chromebooks, and the DESMOS calculator effectively. The independent variable is the teachers' perception of the blended classroom. An individual teacher belief about how they used their educational knowledge to run their classroom successfully is considered teacher perception (Koh et al., 2015). The dependent variable is the student achievement on their second nine weeks mathematics benchmark test. This study only measured student achievement on content only

covered during the second nine weeks in the sixth grade, seventh grade, eighth grade, Algebra 1 and Geometry mathematics courses with scores ranging from 0 to 100.

Research Question

RQ1: How accurately can student achievement be predicted based on teacher perception of blended learning based on their Technology Pedagogical Content Knowledge?

Hypothesis

$H_0$1: There is no predictive relationship between student achievement and teacher perception of blended learning and teacher pedagogical content knowledge.

Participants and Setting

The participants for the study were taken from a middle school where students were given a teacher-made benchmark test used previously in the fall semester of the 2020-2021 school year in a southwestern Virginia school district. The school district has one middle school and parts of the district are rural. The school district invested in its students with a one-to-one Chromebook initiative, ensuring that all students are prepared for the digital world. The reason for selecting this district is that all students in the district have access to the use of Chromebooks and the county decided to use a form of blended learning for the first semester of the 2020-2021 school year.

The blended model the school district chose to implement during the 2020-2021 Fall semester had a double-blocked schedule so that two core subjects and an elective are provided on Mondays and Thursdays. The other two core subjects and electives was provided on Tuesdays and Fridays. The face-to-face part of the instructional day was from 9:15-2:15 with one-hour virtual learning taking place after each school day. The virtual day had one hour of virtual teaching for each of the core classes first block on Mondays, third block on Tuesday, second

block on Thursdays, and fourth block on Fridays. The schedule allowed for a virtual day of instruction on each Wednesday for all core classes, which have 45 minutes per class.

The middle school currently has demographics of 925 students with approximately 85% White, 5.1% Black, 3.6% Hispanic, and 5.7% two or more races. The students at the school come from medium-to-low income levels with about 70% coming from low-income families. The percent of households with broadband internet is 66.7%. The income level for the area is $52,000 pr year.

A rural middle school was used in the study and included 316 students and 5 mathematics teachers. The sample size of this study consisted of (n = 316) students and this meets the minimum requirement of 66 or more students, which is assuming the medium effect size with a statistical power of 0.7 at the 0.05 alpha level (Gall et al., 2007). The study teachers taught students between sixth and eighth grade. The participants would have already been assigned to the classes they are teaching by the guidance department in the summer of 2020. The average class size for those participating had no more than 25 students per class. The participants in the study was teachers who teach students in grades sixth, seventh, and eighth grades. The subjects that are taught in these grades are sixth, seventh, eighth-grade mathematics, Algebra 1, and geometry. Table 1 shows the breakdown of classes teachers per grade level and number of students per grade level used for the study that taught the various classes.

Table 1

Breakdown of Teachers and Students

Grade	Teachers	Number of Students
6th grade	2	126
7th grade	2	121
8th grade	1	58
Algebra I	1	11

Note. The 8th grade teacher also taught Algebra I.

The teachers in the group contained 5 teachers with both positive and negative perceptions about blended learning. The years of teaching experience of the participants in the study ranged between 1 and 29. The students who participated in the study were enrolled in either sixth, seventh, or eighth grade mathematics, or Algebra 1. The total enrollment of the school is 926; the sixth grade had 295 students with 106 students economically disadvantaged, the seventh grade had 332 students with 115 students economically disadvantaged and the eighth grade had 299 students with 88 students economically disadvantaged. The number of English language learners who attend the school is 74 students.

Instrumentation

The instrument that used in this study was the Technology Pedagogical Content Knowledge (TPACK) (see Appendix B). Permission to use the instrument was granted (see Appendix A). The purpose of the TPACK survey is to establish if teachers' perceptions and technological knowledge and how it influences student achievement on the second nine weeks benchmark test in mathematics while teaching in a blended classroom environment. The dependent data was assessed by the benchmark tests given at the end of the second nine weeks during December 2020. The TPACK survey has been used in numerous studies (Koh et al.,

2017; Luik et al., 2018; Pareto & Willermark, 2019; Roussinos & Jimoyiannis, 2019). This research used SurveyMonkey to gather data by using the TPACK survey items.

Technology Pedagogical Content Knowledge Survey

The technology Pedagogical Content Knowledge (TPACK) Survey was originally developed by Shulman (1986). The survey was developed to help understand a teacher's knowledge of content and their pedagogy in respect to their classroom environment. The original TPACK survey included knowledge domains of three components: technology, pedagogy, and content (Schmidt et al., 2009). TPACK is important in a teachers' knowledge of how to be effective in their classroom technology integration and helps to have an impact on how to best train teachers in the best practices in using technology in the classroom (Schmidt et al., 2009). Turgut (2017) used the TPACK survey to show that pre-service teachers' perspectives about teacher education institutes prepare them to integrate information and communication technology into the classroom. The TPACK survey is used to investigate and determine the differences in teachers' knowledge and understanding about how they integrate technology into the classroom environment (Ansyari, 2015).

TPACK is essential to the design of lessons in a classroom today because of the technological knowledge that a teacher needs in lesson plan designs (Koh et al., 2015). Lesson design practices are essential in developing enhanced lessons using a technological format, which has changed over the years of teaching. Design dispositions are important to content design in a classroom because of the rapid pace of classroom technology advancement. The lack of motivation in a changing classroom environment causes a design barrier for teachers in a technological teaching environment.

The TPACK-21CL survey that was used in this study has 18 items that help measure a range of teacher perceptions of teacher design dispositions relates to their TPACK and LDP (Koh et al., 2015). The approximate time to complete the survey is 15 minutes. The survey showed the correlation of how teacher perceptions and their TPACK score influence student scores in a blended learning environment. The items in this survey are measured on a 7-point Likert-type scale rated with: Strongly Agree = 7 , Agree = 6, Slightly Agree = 5, Neither agree nor disagree = 4, Slightly Disagree = 3, Disagree = 2, and Strongly Disagree = 1. The survey is broken up into three parts which include six items from the TPACK Meaningful Learning survey, six items looking at the LDP, and six items looking at DD. These items have Cronbach's alpha scores of at least 0.90. Permission to use the Survey can be seen in Appendix A.

According to Koh et al. (2015), the reliability estimates, based upon the Cronbach's alpha, is shown in Table 2

Table 2

TPACK, LDP, DD Survey Reliability Estimates

Subscale	Reliability Estimate (Cronbach's α)
TPACK	.95
LDP	.94
DD	.91

Benchmark Test

The student benchmark test that was given is a combination of math problems developed by the Comprehensive Instructional Program (CIP). The benchmark test is teacher made which is produced by a consortium of public-school divisions teachers who teach the specific grade level in the summer before each year while looking at data from the previous school year. The

benchmark test is aligned to measure student achievement as it was measured by the Virginia Standards of Learning assessments. The benchmark test is aligned to Virginia's Curriculum Framework in content and rigor, helping teachers to be able to look at the data and prepare students for the state assessments helping to ensure content validity of the benchmark test.

Content validity ensures that a test such as the second benchmark has items from all the standards covered in the second nine weeks of the assessment. The benchmark test administered includes 20-25 questions with a mix of numerical problems and word problems, which come from previous released Virginia Standard of Learning tests and other standardized questions and each student took up to 45 minutes to complete. The benchmark tests are given on an online platform known as Performance Matters and teachers obtain scores instantly and is used to reteach standards in need of improvement.

Procedures

After successful completion of the researcher proposal defense, the researcher must seek approval through the University Liberty Institutional Review Board (IRB) (see Appendix E). Once approved, the researcher was allowed to start collecting data. The researcher contacted the school district superintendent to seek approval before submitting the IRB forms to conduct the study. Once approval from the IRB has been granted, the researcher met with the teachers and principals to talk about the study and the importance of the data that would be collected, and that volunteers are needed to participate in the study. After the meeting, the researcher sent the TPACK survey to principals. The principals then talked to their teachers about the importance of the surveys that they were completely voluntarily. The survey was set up on SurveyMonkey so that the participants' emails can be used to identify them and allow the researcher to match them to their students’ benchmark scores. The survey was loaded to SurveyMonkey to allow for ease

of data retrieval and to secure the data. The teachers' scores from the TPACK survey, which was downloaded from SurveyMonkey into a CSV file that was imported into Statistical Package for the Social Sciences (SPSS). Teachers was given one month to turn in the survey. Participants was told the data collected during the survey will be destroyed once the appropriate amount of time has passed after the study is completed, and the data will remain confidential only to the researcher. After the survey is collected, the information was imported into an excel file to use on SPSS to help calculate the data for each survey that is collected.

The student achievement data obtained for this study was the second nine weeks benchmark test in mathematics that showed the amount of information students remember from the current semester. The second nine weeks benchmark test was retrieved from each school in the study. The data obtained was sorted by students in each teachers' class so that the teacher's surveys can be linked to the students that they teach. The student data was screened for only students who attended a blended learning environment for the nine weeks and who took the benchmark was used for this study. Also, only mathematics teachers who taught in a blended learning environment was used for this study. Teachers did take the TPACK survey on SurveyMonkey and their scores was interpreted with student individual scores. All data that is collected during the study was stored on a password-protected computer and will be destroyed after the defense of the study to help protect the confidentiality of all participants.

Data Analysis

A linear regression was used for this study to analyze the predictive relationship between teachers' TPACK survey score and the students' second nine weeks benchmark score. Linear regression was chosen because of the ability to analyze relationships and the appropriateness to determine the predictive relationship between two variables in this study. Correlation research is

used in studies where the relationship between variables is shown on scatter plots to show if data has a correlation or no correlation (Gall et al., 2007). The null hypothesis was tested using an alpha level of 0.05. Data was screened to determine if there are any outlier data using the assumption of bivariant normal distribution and assumption of linearity.

The assumption of bivariate normal distribution looks at the data collected for the independent variable, which is the teachers' TPACK perceptions score, and the dependent variable, which is the second nine weeks benchmark. The data was placed in a scatterplot to determine if there are any irregularities in the data collected looking for the classic "cigar shape". The Assumption of Linearity used in the study looks at the independent and dependent variables using a scatter plot to determine if any irregularity can be determined. The assumption of bivariate outliers looked at the independent and dependent variables looking for extreme bivariate outliers within the data. The assumption tests were conducted before analyzing data for assumption of bivariate normal distribution, linearity, and bivariate outliers to assure the integrity of the data, in order to help show the relationship between the two variables.

Linear regression is used in studies that have bivariate variables. The independent variable was the teachers' TPACK perceptions score, and the dependent variable was the second nine weeks benchmark score from each student. The study used the latest version of the Statistical Package for the Social Sciences (SPSS) to analyze the data collected. The linear correlation and relationship of the data was evaluated using the SPSS software during the time of the study to show that the X and Y scores are normality distributed.

CHAPTER FOUR: FINDINGS

Overview

Chapter Four will include the findings from the data analysis of this study, the research question, hypothesis, descriptive statistics, assumption testing and bivariate regression. The findings of this chapter have been set up in these five main sections. The research question highlighting the studies purpose of the investigation of the effects of teachers' perception of TPACK to determine the relationship with students' benchmark scores in a blended learning environment. Then, the descriptive statistics looked at the dependent and independent variables to see if there were any errors in the data. Next, the assumption testing looked to see if assumptions of each test were met. Lastly, the bivariate regression was looked at to see if there was a predictive relationship between the variables.

Research Question

RQ1: How accurately can student achievement be predicted based on teacher perception of blended learning based on their technology pedagogical content knowledge?

Null Hypothesis

$H_0$1: There is no predictive relationship between student achievement and teacher perception of blended learning based on teacher pedagogical content knowledge.

Descriptive Statistics

Descriptive statistics were obtained on each of the independent and dependent variables, which are included in Table 3. This study included five teacher surveys and 316 student benchmark scores. The teacher TPACK survey served as the independent variable, which measured teachers' TPACK, LDP and DD by using a seven-point Likert-type scale rated with: Strongly Agree = 7, Agree = 6, Slightly Agree = 5, Neither agree nor disagree = 4, Slightly

Disagree = 3, Disagree = 2, and Strongly Disagree = 1. The student benchmark scores were the dependent variable range from 0 to 100.

Table 3

Descriptive Statistics

	n	Minimum	Maximum	*M*	*SD*
2nd nine weeks benchmark test	316	5.00	100.00	62.83	24.15
TPACK-21CL Survey	5	4.17	6.11	5.26	.63
TPACK	5	4.83	6.17	5.30	.72
LDP	5	4.17	6.00	5.53	.52
DD	5	4.17	6.17	4.97	1.23

Results

First, the researcher sorted the data and scanned for inconsistencies on each variable. No data errors or inconsistencies were identified in the data, so no data points were removed.

Assumption Testing

Assumption of Linearity

The bivariate regression requires that the assumption of linearity be met. Linearity was examined using a scatter plot. The assumption of linearity was met. The bivariate scatter plot can be seen in Figure 2. The assumption of linearity was tested using scatterplots to screen the data to determine if there was a linear relationship between the variables. The TPACK-21CL survey dependent variables included TPACK, DD, and LDP with a dependent variable of student benchmark scores showed linearity between data that was collected as seen in the following figures (see Figures 2, 3, and 4); therefore, the assumption was met.

Figure 2

Simple Scatter plot of TPACK scores

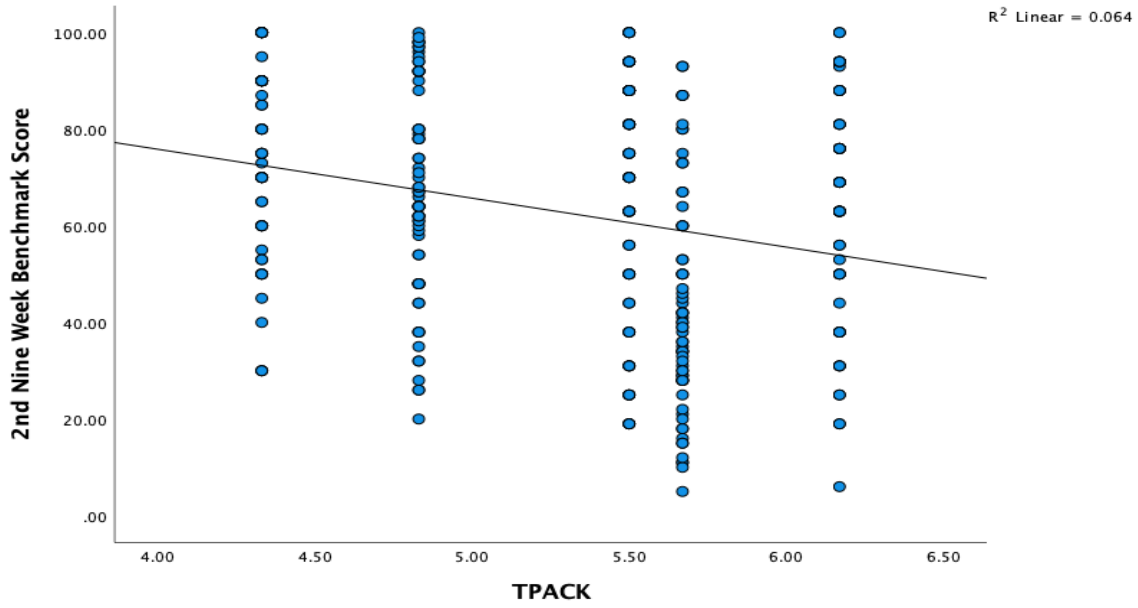


Figure 3

Simple Scatter plot of TPACK scores

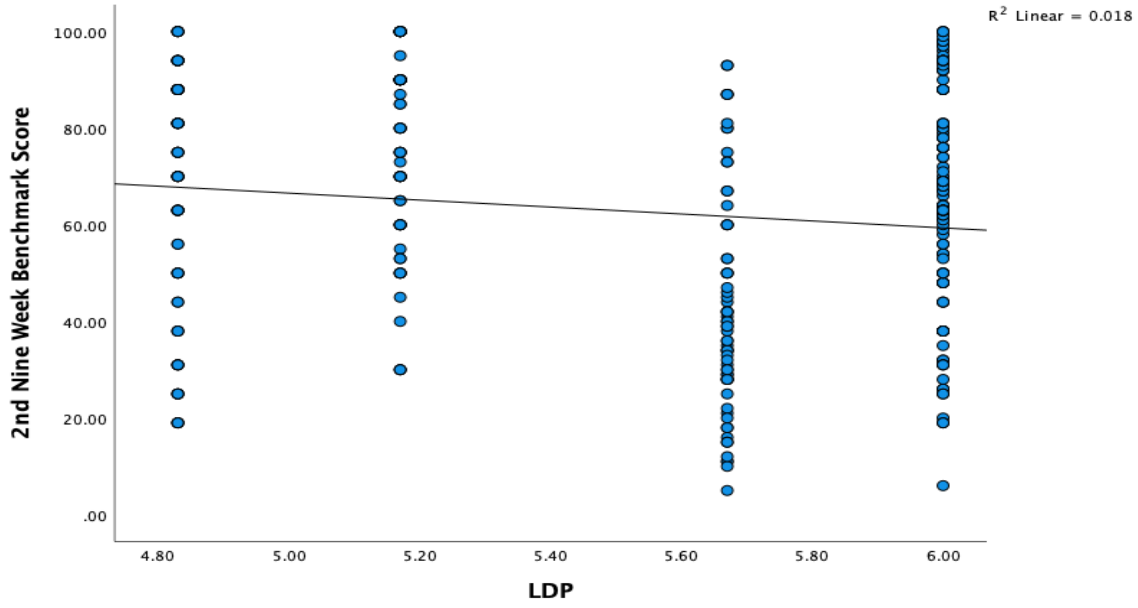
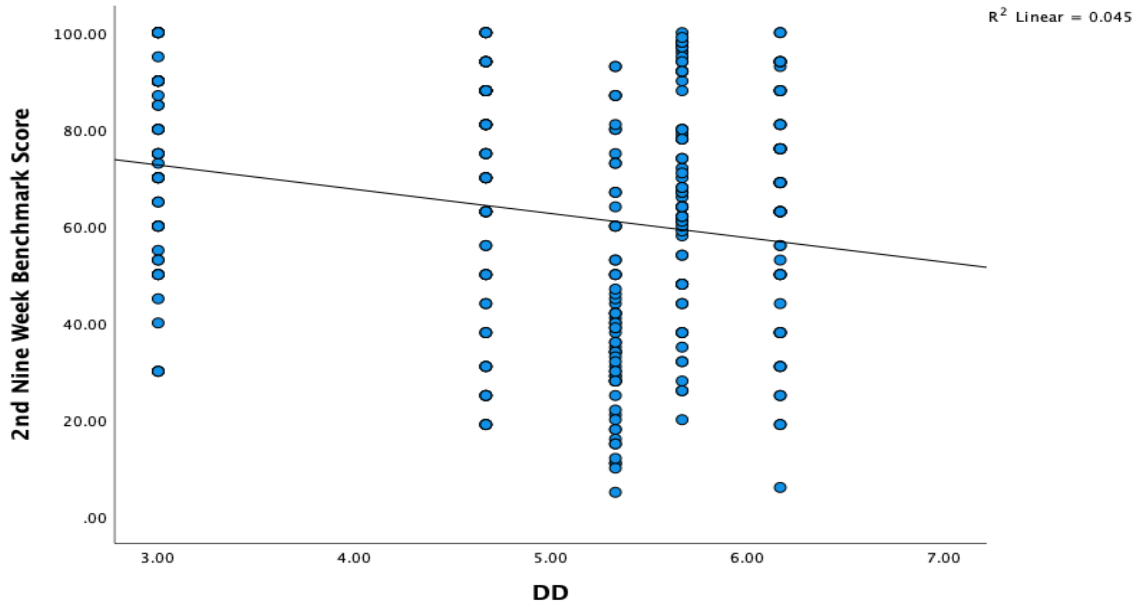


Figure 4

Simple Scatter plot of DD scores

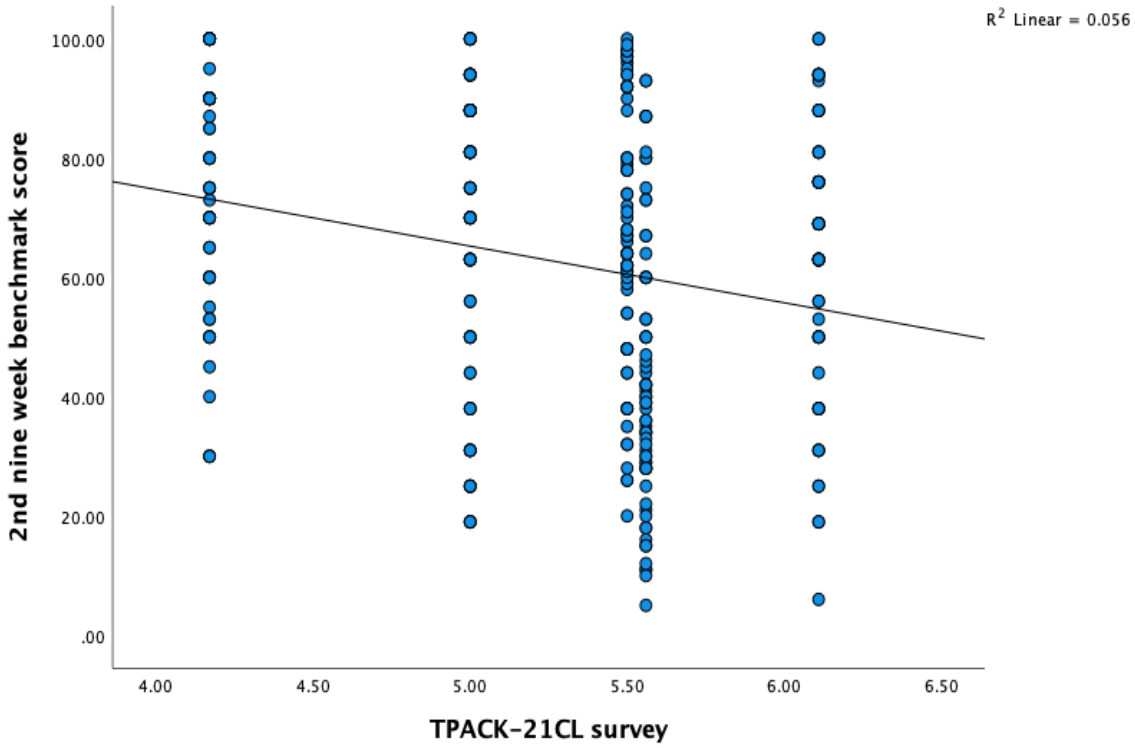


Assumption of Bivariate Outliers

The bivariate regression requires that the assumption of bivariate outliers be met. The assumption of bivariate outliers was examined using a scatter plot. No bivariate outliers were identified in the scatterplot so the assumption of bivariate outliers distribution was met. See Figure 5 for scatterplot.

Figure 5

Scatter plot of Second Nine Weeks and TPACK-21CL Survey



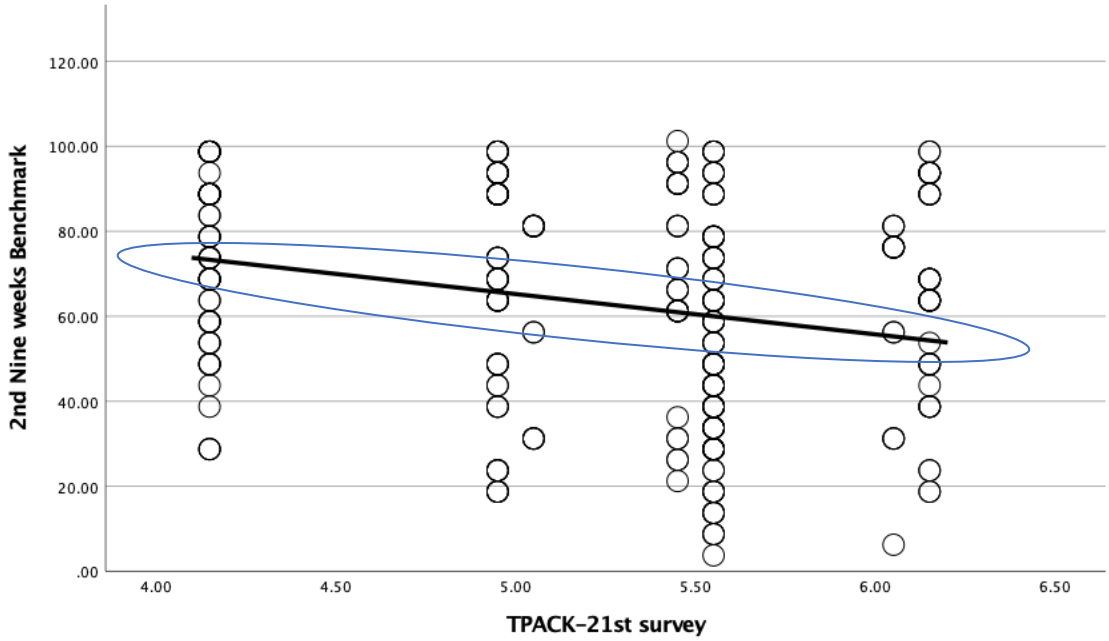
Assumption of Bivariate Normal Distribution

The data was examined to determine if it was symmetrical by using a scatter plot (see Figure 6). Scatter plots looking at the data between second nine weeks benchmark and criterion variable TPACK-21st survey looking for normal distribution. This would be successful and normal if the classic "cigar shape" could be seen in the data.

A classic cigar shape could be seen, so it was determined that there were no extreme bivariate outliers in the data between the second nine weeks benchmark and the TPACK-21ST survey. In the following data screen, a there was a minimum number of outliers and the data was naturally distributed. Therefore, the assumption of bivariate was determined to be tenable.

Figure 6

Scatter plot of Second Nine Weeks and TPACK-21CL Survey



Bivariate Regression Results

A bivariate regression was conducted to see if there was a predictive relationship between student second nine weeks benchmark scores and TPACK-21CL survey exam. The independent variable was TPACK-21CL survey. The dependent variable was student second nine weeks benchmark scores. The researcher rejected the null hypothesis at the 95% confidence level where $F(1,315) = 18.788$, $p < 0.001$. Therefore, there was a statistically significant, predictive relationship between the independent variable (TPACK-21CL survey) and the dependent variable (student second nine weeks benchmark scores). See Table 4 for regression model results.

Table 4

ANOVA

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Regression	11346.412	1	11246.412	18.788	<.001
Residual	187961.015	314	598.602		
Total	199207.427	315			

The model's effect size was extremely large where $R = 0.238$. Furthermore, $R^2 = 0.056$ indicating that approximately 5.6% of the variance of the student second nine weeks benchmark scores can be explained by its linear relationship with TPACK-21CL survey. See Table 5 for model summary.

Table 5

Model Summary

R	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
.238	.56	.53	24.466

CHAPTER FIVE: CONCLUSIONS

Overview

Chapter Five will include a discussion of the study, implications, limitations, and recommendations for future research. The discussion will review the literature review looking at blended learning environments. Next, implications were examined, and how the study results can be used in education. This study's limitations were examined to see how it could have impacted the data obtained from this study. Lastly, recommendations will be given for future research to expand the study of blended learning environments.

Discussion

This quantitative, correlational research study aimed to investigate the effects of teachers' perception of TPACK to determine the relationship it has on students' benchmark scores in a blended learning environment. This study data showed a significant predictive ability of a teacher's TPACK score in a blended learning environment since the $p<0.001$. Teachers' TPACK scores had a predictive relationship with student benchmark scores. This is shown by the averages of each of the five teachers' benchmark tests vs. their TPACK, LDP, and DD scores by being statistically significant, since $p<0.001$

The statistical predictive relationship between the TPACK-21CL survey and the student second nine weeks benchmark scores could be due to a few factors. The difference in the scores could be the subject material taught by the teacher and how the teacher used technology in their lessons. Considering the study took place during a pandemic and teachers and students were thrown into a new learning environment could have an influence on their scores. This situation would change teachers who might have been reluctant to learn new technology forced to in this school year, causing a change in their motivation to learn new technology. This concept implies

Nayar and Koul's (2020) thoughts based on the blended learning environment in which this study took place during the pandemic.

Teachers and students did not have the ability or flexibility to have a choice over the type of learning environment during the pandemic. This new blended learning environment could have caused difficulty in learning material during the second nine weeks helping influence the second nine weeks' benchmark tests due to the change to a blended learning environment (Thai et al., 2020). During this time, students and teachers did not have time to consider if they liked the new teaching style during the pandemic; they needed to focus on learning and getting through the material. The fear and inexperience of using the Chromebooks could have caused students to be unsure when using them for classroom assignments. In addition, this could have been the students first computer, which happened during the pandemic and was rushed. This rush created little time for training to prepare students and teachers for a new blended-learning classroom.

The change in the teaching environment to use mobile technology in pedagogy in teaching students through Chromebooks became necessary during the pandemic. The abrupt technology integration, sweeping changes in classroom decisions, and support from multiple sources gave teachers help while making them feel supported during the transition. The amount of technology that was introduced allowed teachers to have multiple ways to interact with students Foldnes (2016) mentioned the problem was the amount of time allowed to learn the new technology. During the time period of the study teachers had to learn new ways to integrate old lessons to a format that could be used primary on a mobile device so that all students had access to the lessons being taught by using only their mobile devices.

The number of changes to the teaching environment did allow for new ways of transmission of content through multiple different methods during the pandemic. The challenge was helping students and teachers to embrace the change that was expected of them. The other problem was the constant fear of missing weeks of in-person instruction and only having online instruction if classes were missed. The number of applications on the Chromebook and computer tools used during the pandemic increased, including Canvas and IXL, to help provide students with content in a collaborative setting in and outside the classroom. Using these programs even though they could have been used before in classroom instruction. This helped increase technology use in the classroom because now students constantly had access to their Chromebook all the time instead of just having primary access to them at the school.

Implications

This study set out to see if there were significant differences in student benchmark scores based on a teacher's TPACK survey. The study showed that student achievement could be predicted based on teacher perception of blended learning based on their TPACK score. This study's data came during the pandemic, a time of uncertainty in teaching because both students and teachers had multiple absences and missed many days due to quarantines.

The focus of the study was the teacher's perception of blended learning based on their TPACK and how it influenced student benchmark scores. Based upon the data, it should serve as a framework to set up an example of how this study showed that if districts decide to change to a blended learning style format completely. In this study, the data shows that teachers could handle the change considering that the TPACK survey showed similar results, including the benchmark.

This study should be conducted again, allowing time for teachers to grasp the blended learning environment during a typical school year that is not plagued with absent students and

teachers for weeks at a time. These interruptions could have caused benchmark scores to differ from a school year, not during a pandemic. This factor would need to be considered if this study were conducted again. The other advantage of having this conducted again later is that teachers will have had time to master and learn new software to help them in their pedagogy. This would help researchers to fully understand what direction they feel is best for their teaching style when using technology and Chromebooks in the classroom.

Limitations

This study's limitations are the lack of training teachers had on canvas before the study started. This training happened just before the beginning of the school year due to the pandemic. Another limitation was that teachers needed to understand the definition of blended learning even though the definition was provided to them and was reluctant to fill out the survey. This resulted in fewer teachers filling out the survey than anticipated. This shows that during the pandemic, teachers were doing their job and trying to teach students and not recognizing their changing educational environment, which has now become the regular teaching practice due to the availability of Chromebooks. Future studies would benefit from conducting a study in a district with a blended learning environment that has formally trained its instructors on the new software programs that will be implemented before the school year begins.

Another area for improvement was surveying promptly during the school year the study happened. Due to teachers leaving the field or moving, the study lost several participants that could have potentially participated in the study. The school system was chosen out of convenience and during the covid pandemic in the 2020-2021 school year. The ability to do the survey earlier could have resulted in a better reembrace of their feelings during that period and potentially a different score on the survey.

Recommendations for Future Research

Recommendations for further research are needed when school is on a regular schedule, and there is little risk of interruptions in learning—the following suggestions for future research.

1. Larger sample sizes of teachers, which could focus on multiple subjects instead of mathematics.
2. Collect data in blended learning schools that have been established for a few years.
3. Gather data on student perceptions of blended learning.
4. Gather data on the percentage of students accessing the internet outside the school building.
5. Collect data from school using the same test but not teaching in a blended learning environment.

REFERENCES

Abidin, Z., Mathrani, A., Hunter, R., & Parsons, D. (2017). Challenges of integrating mobile technology into mathematics instruction in secondary schools: An Indonesian context. *Computers in the Schools, 34*(3), 207-222. https://doi.org/10.1080/07380569.2017.1344056

Afify, M. K. (2020). Effect of interactive video length within E-learning environments on cognitive load, cognitive achievement and retention of learning. Turkish Online Journal of Distance Education, 68-89. https://doi.org/10.17718/tojde.803360

Agyei, D. D., & Voogt, J. M. (2015). Pre-service teachers' TPACK competencies for spreadsheet integration: Insights from a mathematics-specific instructional technology course. Technology, *Pedagogy and Education, 24*(5), 605-625. https://doi.org/10.1080/1475939X.2015.1096822

Ahmed Qasem, A., & Viswanathappa, G. (2016). The teachers' perception towards ICT integration: Professional development through blended learning. *Journal of Information Technology Education, 15*, 561-575. https://doi.org/10.28945/3562

Ansyari, M. F. (2015). Designing and evaluating a professional development program for basic technology integration in english as a foreign language (EFL) classrooms. *Australasia Journal of Educational Technology, 31*(6) https://doi.org/10.14742/ajet.1675

Barreh, K. A., & Abas, Z. W. (2015). A Framework for Mobile Learning for Enhancing Learning in Higher Education. https://eric.ed.gov/?id=EJ1085946

Bartholomew, S. R., Reeve, E., Veon, R., Goodridge, W., Lee, V., & Nadelson, L. (2017). Relationships between access to mobile devices, student self-directed learning, and achievement. *Journal of Technology Education, 29*(1) https://doi.org/10.21061/jte.v29i1.a.1

Borba, M. C., Askar, P., Engelbrecht, J., Gadanidis, G., Llinares, S., & Aguilar, M. S. (2016). Blended learning, e-learning and mobile learning in mathematics education. *Zdm, 48*(5), 589-610. https://doi.org/10.1007/s11858-016-0798-4

Boshoff, E., & Laher, S. (2017). Understanding learner attitudes towards the use of tablets in a blended learning classroom. *Perspectives in Education, 35*(1), 200-213. https://doi.org/10.18820/2519593X/pie.v35i1.15

Bray, A., & Tangney, B. (2016). Enhancing student engagement through the affordances of mobile technology: A 21st century learning perspective on Realistic Mathematics Education. *Mathematics Education Research Journal, 28*(1), 173–197.

Burden, K. J., & Kearney, M. (2017). Investigating and critiquing teacher educators' mobile learning practices. *Interactive Technology and Smart Education, 14*(2), 110-125. https://doi.org/10.1108/ITSE-05-2017-0027

Conijn, R., van den Beemt, A., & Cuijpers, P. J. L. (2018). Predicting student performance in a blended MOOC. *Journal of Computer Assisted Learning, 34*(5), 615-628. https://doi.org/10.1111/jcal.12270

Daher, W., & Baya'a, N. (2014). In-service and Pre-service Middle School Mathematics Teachers' Attitudes and Decisions Regarding Teaching Mathematics Using Mobile Phones. International *Journal of Interactive Mobile Technologies (iJIM), 8* (4), 4-13.

Dalby, D., & Swan, M. (2019). Using digital technology to enhance formative assessment in mathematics classrooms. *British Journal of Educational Technology, 50*(2), 832-845. https://doi.org/10.1111/bjet.12606

Danielson, C., & Meyer, D. (2016). Increased participation and conversation using networked devices. *The Mathematics Teacher, 110*(4), 258-264. https://doi.org/10.5951/mathteacher.110.4.0258

Edannur, S., & Marie, S. M. J. A. (2017). improving student teachers' perceptions on technology integration using a blended learning programme. *I-Manager's Journal on School Educational Technology, 13*(2), 31. https://doi.org/10.26634/jsch.13.2.13829

Ellis, R. A., & Ellis, R. A. (2016). Students' approaches to groupwork in a blended course, associations with perceptions of the online environment and academic achievement – when is learning engaged? *Education and Information Technologies, 21*(5), 1095-1112. https://doi.org/10.1007/s10639-014-9370-4

Emelyanova, N., & Voronina, E. (2017). Introducing blended learning in the english language classroom: Students' attitudes and perceptions before and after the course. *Knowledge Management & e-Learning, 9*(1), 33-49. https://doi.org/10.34105/j.kmel.2017.09.003

Fabian, K., Topping, K. J., & Barron, I. G. (2018). Using mobile technologies for mathematics: Effects on student attitudes and achievement. *Educational Technology Research and Development 66(5), 1119-1139,* https://doi.org/*10.1007/s11423-018-9580-*

Feitosa de Moura, V., Alexandre de Souza, C., & Noronha Viana, A. B. (2021). The use of massive open online courses (MOOCs) in blended learning courses and the functional value perceived by students. *Computers and Education, 161* https://doi.org/10.1016/j.compedu.2020.104077

Foldnes, N. (2016). The flipped classroom and cooperative learning: Evidence from a randomized experiment. *Active Learning in Higher Education, 17*(1), 39-49. https://doi.org/10.1177/1469787415616726

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). *Educational research: An introduction* (8th ed.). Allyn & Bacon. ISBN: 9780205488490.

Graham, C. R., Borup, J., & Smith, N. B. (2012). Using TPACK as a framework to understand teacher candidates' technology integration decisions. *Journal of Computer Assisted Learning, 28*(6), 530-546. https://doi.org/10.1111/j.1365-2729.2011.00472.x

Heflin, H., Shewmaker, J., & Nguyen, J. (2017). Impact of mobile technology on student attitudes, engagement, and learning. *Computers and Education, 107*, 91-99. https://doi.org/10.1016/j.compedu.2017.01.006

Honey, S. (2018). Graphics calculators in the primary classroom: Student-teacher's beliefs and the TPACK framework. *The International Journal for Technology in Mathematics Education, 25*(3), 3-16. https://doi.org/10.1564/tme_v25.3.01

Hrastinski, S. (2019). What do we mean by blended learning? *Techtrends, 63*(5), 564-569. https://doi.org/10.1007/s11528-019-00375-5

Hwang, G., & Lai, C. (2017). Facilitating and bridging out-of-class and in-class learning: An interactive E-book-based flipped learning approach for math courses. *Journal of Educational Technology & Society, 20*(1), 184-197.

Hwang, G., Lai, C., Liang, J., Chu, H., & Tsai, C. (2018). A long-term experiment to investigate the relationships between high school students' perceptions of mobile learning and peer interaction and higher-order thinking tendencies. *Educational Technology Research and Development, 66*(1), 75-93. https://doi.org/10.1007/s11423-017-9540-3

Jeong, J. S., González-Gómez, D., & Cañada-Cañada, F. (2016). Students' perceptions and emotions toward learning in a flipped general science classroom. *Journal of Science Education and Technology, 25*(5), 747-758. https://doi.org/10.1007/s10956-016-9630-8

Johnson, N. F. (2019). Dysfunctional devices in the classroom meet the habitus of the new. *E-Learning and Digital Media*, *16*(3), 208–220. https://doi.org/10.1177/2042753019831385

King, A. (2017). Using Desmos to draw in mathematics. Australian Mathematics Teacher, 73(2), 33+. https://link-gale-com.ezproxy.liberty.edu/apps/doc/A498845403/AONE?u=vic_liberty&sid=AONE&xid=334bfc3b

Koehler, M. J. (2012). *Using the tpack image.* http://tpack.org/

Koehler, M. J., & Mishra, P. (2005). What happens when teachers design educational technology? the development of technological pedagogical content knowledge. *Journal of Educational Computing Research, 32*(2), 131-152. https://doi.org/10.2190/0EW7-01WB-BKHL-QDYV

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60-70.

Koh, J. H. L., & Chai, C. S. (2016). Seven design frames that teachers use when considering technological pedagogical content knowledge (TPACK). *Computers and Education, 102*, 244-257. https://doi.org/10.1016/j.compedu.2016.09.003

Koh, J. H. L., Chai, C. S., Benjamin, W., & Hong, H. Y. (2015). Technological Pedagogical Content Knowledge (TPACK) and Design Thinking: A Framework to Support ICT Lesson Design for 21st Century Learning. The Asia-Pacific Education Researcher, 24, 535-543. https://doi.org/10.1007/s40299-015-0237-2

Koh, J. H. L., Chai, C. S., & Lim, W. Y. (2017). Teacher professional development for TPACK-21CL: Effects on teacher ICT integration and student outcomes. *Journal of Educational Computing Research, 55*(2), 172-196. https://doi.org/10.1177/0735633116656848

Liang, X., & Luo, J. (2015). Micro-lesson design: A typical learning activity to develop pre-service mathematics teachers' TPACK framework. Paper presented at the 259-263. https://doi.org/10.1109/EITT.2015.61

Limniou, M., Schermbruker, I., & Lyons, M. (2018). Traditional and flipped classroom approaches delivered by two different teachers: The student perspective. *Education and Information Technologies, 23*(2), 797–817. https://doi.org/10.1007/s10639-017-9636-8.

Lin, C., & Hwang, G. (2018). A learning analytics approach to investigating factors affecting EFL students' oral performance in a flipped classroom. *Journal of Educational Technology & Society, 21*(2), 205-219.

Lu, O. H. T., Huang, A. Y. Q., Huang, J. C. H., Lin, A. J. Q., Ogata, H., & Yang, S. J. H. (2018). Applying learning analytics for the early prediction of students' academic performance in blended learning. *Journal of Educational Technology & Society, 21*(2), 220-232.

Luik, P., Taimalu, M., & Suviste, R. (2018). Perceptions of technological, pedagogical and content knowledge (TPACK) among pre-service teachers in estonia. *Education and Information Technologies, 23*(2), 741-755. https://doi.org/10.1007/s10639-017-9633-y

Marco, L. D., Venot, A., & Gillois, P. (2017). Does the acceptance of hybrid learning affect learning approaches in France? Journal of Educational Evaluation for Health Professions, 14http://dx.doi.org.ezproxy.liberty.edu/10.3352/jeehp.2017.14.24

Martínez, S., Guíñez, F., Zamora, R., Bustos, S., & Rodríguez, B. (2020). On the instructional

model of a blended learning program for developing mathematical knowledge for teaching. *Zdm, 52*(5), 877-891. https://doi.org/10.1007/s11858-020-01152-y

Mcgloinet, R., Mcgillicuddy, K. T., & Christensen, J. L. (2017). The impact of goal achievement orientation on student technology usage in the classroom. *Journal of Computing in Higher Education, 29*(2), 240-266. http://dx.doi.org.ezproxy.liberty.edu/10.1007/s12528-017-9134-4

McMullen, J., Hannula-Sormunen, M., Kainulainen, M., Kiili, K., & Lehtinen, E. (2019). Moving mathematics out of the classroom: Using mobile technology to enhance spontaneous focusing on quantitative relations. *British Journal of Educational Technology, 50*(2), 562-573. https://doi.org/10.1111/bjet.12601

Molnar, K. K., & Molnar, K. K. (2017). What effect does flipping the classroom have on undergraduate student perceptions and grades? *Education and Information Technologies, 22*(6), 2741-2765. https://doi.org/10.1007/s10639-016-9568-8

Muir, T., & Geiger, V. (2016). The affordances of using a flipped classroom approach in the teaching of mathematics: A case study of a grade 10 mathematics class. *Mathematics Education Research Journal, 28*(1), 149-171. https://doi.org/10.1007/s13394-015-0165-8

Nayar, B., & Koul, S. (2020). Blended learning in higher education: A transition to experiential classrooms. *International Journal of Educational Management, ahead-of-print*(ahead-of-print), 1357-1374. https://doi.org/10.1108/IJEM-08-2019-0295

Nickels, M., & Gartner, A. (2018). Rethinking the Mathematics Block: A Blended STEM Approach, Kappa Delta Pi Record, 54:4, 186-1
89, DOI: 10.1080/00228958.2018.1515548

Onyema, O., & Daniil, P. (2017). Educating the 21st century learners: Are educators using appropriate learning models for honing skills the mobile age? *Journal of Entrepreneurship Education; Arden*, 20(2), 1-15.

Orlando, J., & Attard, C. (2016). Digital natives come of age: The reality of today's early career Teachers using mobile devices to teach mathematics. *Mathematics Education Research Journal, 28*(1), 107. https://doi.org/10.1007/s13394-015-0159-6

Papanikolaou, K., Makri, K., & Roussos, P. (2017). Learning design as a vehicle for developing TPACK in a blended teacher training on technology enhanced learning. International Journal of Educational Technology in Higher Education, 14(1), 1-14. doi:10.1186/s41239-017-0072-z

Parajuli, K. P. (2016). Mobile Learning Practice in Higher Education in Nepal. *Open Praxis,* v8 n1 p41-54.

Pareto, L., & Willermark, S. (2019). TPACK in situ: A design-based approach supporting professional development in practice. *Journal of Educational Computing Research, 57*(5), 1186-1226. https://doi.org/10.1177/0735633118783180

Parsons, D. (2014). A mobile learning overview by timeline and mind map. *International Journal of Mobile and Blended Learning (IJMBL), 6*(4), 1-21. https://doi.org/10.4018/ijmbl.2014100101

Perry, D. R., & Steck, A. K. (2015). Increasing student engagement, self-efficacy, and meta-cognitive self-regulation in the high school geometry classroom: Do iPads help? *Computers in the Schools, 32*(2), 122-143. https://doi.org/10.1080/07380569.2015.1036650

Phillips, J. A., Schumacher, C., & Arif, S. (2016). Time spent, workload, and student and faculty

perceptions in a blended learning environment. *American Journal of Pharmaceutical Education, 80*(6), 102. https://doi.org/10.5688/ajpe806102

Pinto-Llorente, A. M., Sánchez-Gómez, M. C., García-Peñalvo, F. J., & Casillas-Martín, S. (2017). Students' perceptions and attitudes towards asynchronous technological tools in blended-learning training to improve grammatical competence in english as a second language. *Computers in Human Behavior, 72*, 632-643. https://doi.org/10.1016/j.chb.2016.05.071

Rice, M., & Ortiz, K. (2021). Evaluating digital instructional materials for K-12 online and blended learning. *Tech Trends*, *65*(6), 977- 992. https://doi.org/10.1007/s11528-021-00671-z

Roussinos, D., & Jimoyiannis, A. (2019). Examining primary education teachers' perceptions of TPACK and the related educational context factors. *Journal of Research on Technology in Education, 51*(4), 377-397. https://doi.org/10.1080/15391523.2019.1666323

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological Pedagogical Content Knowledge (TPACK). *Journal of Research on Technology in Education*, 42(2), 123-149. https://https://doi.org/10.1080/15391523.2009.10782544

Shariman, T. P. N. T., Talib, O., & Othman, A. (2017). OCRA, a Mobile Learning Prototype for Understanding Chemistry Concepts. https://eric.ed.gov/?id=ED579460

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*, 4–14. https://doi.org/10.2307/1175860

Subramaniam, T., Suhaimi, N., Latif, A., Abu Kassim, Z., & Fadzil, M. (2019). MOOCs

Readiness: The Scenario in Malaysia. International Review of Research in Open and Distributed Learning, 20(3). 80-101 https://doi.org/10.19173/irrodl.v20i3.3913

Swallow, M. J. C., & Olofson, M. W. (2017). Contextual understandings in the TPACK framework. *Journal of Research on Technology in Education, 49*(3-4), 228-244. https://doi.org/10.1080/15391523.2017.1347537

Tang, C. M., & Chaw, L. Y. (2016). *Digital Literacy: A prerequisite for effective learning in a blended learning environment?.* Electronic Journal of e-Learning. https://eric.ed.gov/?id=EJ1099109

Thai, N. T. T., De Wever, B., & Valcke, M. (2020). Face-to-face, blended, flipped, or online learning environment? impact on learning performance and student cognitions. *Journal of Computer Assisted Learning, 36*(3), 397-411. https://doi.org/10.1111/jcal.12423

Tourón, J., Navarro-Asencio, E., Lizasoain, L., López-González, E., & García-San Pedro, M. J. (2019). How teachers' practices and students' attitudes towards technology affect mathematics achievement: Results and insights from PISA 2012. *Research Papers in Education*, *34*(3), 263–275. https://doi.org/10.1080/ 02671522.2018.1424927

Turgut, Y. (2017). Tracing preservice English language teachers' perceived TPACK in sophomore, junior, and senior levels. *Cogent Education*, *4*(1). https://doi.org/10.1080/2331186x.2017.1368612

Van Leeuwen, A. (2018). Teachers' perceptions of the usability of learning analytics reports in a flipped university course: When and how does information become actionable knowledge? *Educational Technology Research and Development*, *67*(5), 1043–1064. https://doi.org/10.1007/s11423-018-09639-y

Wai, C. C., Wai, C. C., Seng, E. L. K., & Seng, E. L. K. (2015). Measuring the effectiveness of

blended learning environment: A case study in malaysia. *Education and Information Technologies, 20*(3), 429-443. https://doi.org/10.1007/s10639-013-9293-5

Wang, Y., Huang, X., Schunn, C. D., Zou, Y., & Ai, W. (2019). Redesigning flipped classrooms: A learning model and its effects on student perceptions. *Higher Education, 78*(4), 711-728. https://doi.org/10.1007/s10734-019-00366-8

Willacy, H., & Calder, N. (2017). Making mathematics learning more engaging for students in health schools through the use of apps. *Education Sciences, 7*(2), 48. https://doi.org/10.3390/educsci7020048

Xue, J., Zhang, X., & Luo, H. (2018). Effects of Mobile Learning on Academic Performance and Learning Attitude in a College Classroom. DEStech Transactions on Social Science, Education and Human Science, (Icaem). https://doi.org/10.12783/dtssehs/icaem2017/19095

APPENDIX A

1/26/23, 10:50 PM

[External] RE: TPACK survey

[redacted]

To: Pizzino, Jason DeWayne [redacted]

[EXTERNAL EMAIL: Do not click any links or open attachments unless you know the sender and trust the content.]

Dear Jason,
Thanks for your interest in the TPACK instrument. Please go ahead to use the survey with the following citation:

Koh, J. H. L., Chai, C. S., Hong, H. Y., & Tsai, C. C. (2015). A survey to examine teachers' perceptions of design dispositions, lesson design practices, and their relationships with technological pedagogical content knowledge (TPACK). *Asia-Pacific Journal of Teacher Education, 43*(5), 378-391. https://doi.org/https://doi.org/10.1080/1359866X.2014.941280

All the best for your study.

Regards,
Joyce

From: Pizzino, Jason DeWayne [redacted]
Sent: Monday, 17 May 2021 3:16 PM
To: Joyce Koh [redacted]
Subject: TPACK survey

Dear Dr. Koh,

I am a doctoral student at Liberty University in Lynchburg, VA. I am writing a dissertation that is tentatively title " The impact of student achievement in a blended learning environment and the teachers' perceptions of TPACK." I would like to use your survey instrument " A survey to examine teachers' perceptions of design dispositions, lesson design practices, and their relationships with technological pedagogical content knowledge (TPACK)" in my doctoral dissertation. Would you allow this use?

Thank you for your time and consideration, and please let me know if you have any questions.

Sincerely,

Jason Pizzno

APPENDIX B

Items

TPACK1 – I can formulate in-depth discussion topics about the content knowledge and facilitate students' online collaboration with appropriate tools (e.g. Google Sites, CoveritLive).

TPACK2 – I can craft real-world problems about the content knowledge and represent them through computers to engage my students.

TPACK3 – I can structure activities to help students to construct different representations of the content knowledge using appropriate ICT tools (e.g. Webspiration, Mindmaps, Wiki).

TPACK4 – I can create self-directed learning activities for the content knowledge with appropriate ICT tools (e.g. Blog, Webquest).

TPACK5 – I can design inquiry activities to guide students to make sense of the content knowledge with appropriate ICT tools (e.g. simulations, web-based materials).

TPACK6 – I can design lessons that appropriately integrate content, technology and pedagogy for student-centred learning.

LDP1 – When designing a blended learning lesson, I start by playing with a few lesson ideas.

LDP2 – When designing a blended learning lesson, I consider several lesson ideas to see if they adequately address students' learning problems before choosing one idea.

LDP3 – When designing a blended learning lesson, I allow conflicting lesson ideas to coexist until I feel that I have adequately understood the learning problems.

LDP4 – When designing a blended learning lesson, I continually refine my lesson ideas as I develop new understandings throughout the design process.

LDP5 – When designing a blended learning lesson, I consider the consequences of adopting particular lesson ideas before working out its details.

LDP6 – When designing a blended learning lesson, I am prepared to completely change my lesson ideas if needed.

DD1 – I am comfortable with the presence of uncertainty.

DD2 – I am open to new experiences.

DD3 – I am comfortable to explore conflicting ideas.

DD4 – I am comfortable to deviate from established practices.

DD5 – I am comfortable with occasional failures from trying out new approaches for ICT lessons.

DD6 – I am constantly seeking to turn constraints into opportunities.

APPENDIX C

Dear [Recipient]:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Educational Doctorate in Curriculum and Instruction: Secondary Education degree. The purpose of my research is to determine how accurately can student achievement be predicted based on teacher perception of blended learning and I am writing to invite eligible participants to join my study.

Participants must have taught mathematics during the 2020-2021 school year at [redacted]. Participants, if willing, will be asked to take a survey on SurveyMonkey in the link provided. It should take approximately 5 minutes to complete. Your name and/or other identifying information will be requested as part of your participation, but the information will remain confidential.

To participate in this study, please click the link at the bottom of the page. A consent document is provided as the first page you will see after you click on the survey link and a copy has been attached to this email. The consent document contains additional information about my research. Please click on the questionnaire link to read the consent information or read the consent document attached to this email. There will be a place for you to sign to indicate that you have read the consent document and would like to take part in the study.

To participate, please [click here}

Sincerely,

Jason Pizzino
[redacted]

APPENDIX D

[redacted] 1/26/23, 10:59 PM

Gmail [redacted]

Doctoral Study

[redacted] Tue, Apr 20, 2021 at 2:51 PM

I am doctoral candidate at Liberty University. My study is focusing on the hybrid model used in the fall of 2020 and how the teachers' TPACK knowledge may have influenced students' scores in 6th grade Math. I am writing you to ask if I can have permission to send the 6th grade math teachers a TPACK survey to fill out that will take approximately 15-20 minutes, and then match that with their students' benchmark from the 2nd nine weeks. This will only happen after I have IRB approval. Thank you for your time.

Sincerely,

Jason Pizzino

[redacted]

[redacted]

1/26/23, 11:00 PM

Gmail

Ja[redacted]

Doctoral Study

[redacted]

Tue, Apr 20, 2021 at 2:55 PM

To: J[redacted]
Cc: [redacted]

Mr. Pizzino,

Yes, you have my permission to offer a voluntary survey to [redacted] math teachers and to use student benchmark data as long as student names or other identifying information isn't included in the study. Please let me know if there is anything else that I can do to help.

[redacted]

APPENDIX E: IRB letter

Date: 1-26-2023

IRB #: IRB-FY21-22-1128
Title: THE IMPACT OF STUDENT ACHIEVEMENT BASED UPON THE DIFFERENCES BETWEEN TEACHER PERCEPTION OF BLENDED LEARNING AND THEIR TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE
Creation Date: 5-23-2022
End Date:
Status: Approved
Principal Investigator: Jason Pizzino
Review Board: Research Ethics Office
Sponsor:

Study History

Submission Type	Review Type	Decision
Initial	Limited	Exempt - Limited IRB

Key Study Contacts

Member Rebecca Lunde	Role Co-Principal Investigator	Contact [redacted]
Member Jason Pizzino	Role Principal Investigator	Contact [redacted]
Member Jason Pizzino	Role Primary Contact	Contact [redacted]

APPENDIX F: Consent

Consent

Title of the Project: THE IMPACT OF STUDENT ACHIEVEMENT BASED UPON THE DIFFERENCES BETWEEN TEACHER PERCEPTION OF BLENDED LEARNING AND THEIR TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE

Principal Investigator: Jason Pizzino, Doctoral candidate

Invitation to be Part of a Research Study

You are invited to participate in a research study. To participate, you must have taught mathematics during the 2020-2021 school year at [redacted] Taking part in this research project is voluntary.

Please take time to read this entire form and ask questions before deciding whether to take part in this research.

What is the study about and why is it being done?

The purpose of the study is to determine how accurately can student achievement be predicted based on teacher perception of blended learning. This study will examine if a teachers' perception of the TPACK including information and communication technologies in a blended learning environment predicts their students' scores on the second nine weeks benchmark test.

What will happen if you take part in this study?

If you agree to be in this study, I will ask you to do the following things:

1. Click on the link provided and take a survey on SurveyMonkey and once finished submit the survey.

How could you or others benefit from this study?

Participants should not expect to receive a direct benefit from taking part in this study.

Benefits to society include seeing how blended learning and the use of technology impacts student scores on assignments such as benchmark test, state tests, and daily assignments. In schools that heavily rely upon blended learning models to teach.

What risks might you experience from being in this study?

The risks involved in this study include are minimal, which means they are equal to the risks you would encounter in everyday life.

How will personal information be protected?

The records of this study will be kept private. Published reports will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only

the researcher will have access to the records. Data collected from you may be shared for use in future research studies or with other researchers. If data collected from you is shared, any information that could identify you, if applicable, will be removed before the data is shared.

- Participant responses will be anonymous.
- Data will be stored on a password-locked computer and may be used in future presentations. After three years, all electronic records will be deleted.

Is study participation voluntary?

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

What should you do if you decide to withdraw from the study?

If you choose to withdraw from the study, please exit the survey and close your internet browser. Your responses will not be recorded or included in the study.

Whom do you contact if you have questions or concerns about the study?

The researcher conducting this study is Jason Pizzino. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact him [redacted] or [redacted] You may also contact the researcher's faculty sponsor, Dr. Lunde, at [redacted]

Whom do you contact if you have questions about your rights as a research participant?

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA 24515 or email at [redacted]

Disclaimer: The Institutional Review Board (IRB) is tasked with ensuring that human subjects research will be conducted in an ethical manner as defined and required by federal regulations. The topics covered and viewpoints expressed or alluded to by student and faculty researchers are those of the researchers and do not necessarily reflect the official policies or positions of Liberty University.

Your Consent

Before agreeing to be part of the research, please be sure that you understand what the study is about. You will be emailed a copy of this document for your records/you can print a copy of the document for your records. If you have any questions about the study later, you can contact the researcher using the information provided above.

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study