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THE EFFECTS OF BLENDED LEARNING ON A CLASSROOM IN COMPARISON TO A TRADITIONAL CLASSROOM

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Abstract

"By 2020, 77% of all jobs will require some form of technological skills with more jobs to be filled than qualified candidates" (Schuyler & Buckley, 2018, para. 2). Because of this, there is a strong need for students to be competent using technology. This is a study to determine if (1) student achievement is higher in fifth grade math when students are in a blended learning setting or a more traditional setting? Furthermore, (2) does the implementation of blended learning affect student learning based on gender? A sample of STAR Math scores for one school year of two fifth grade classes in two schools within the same district were analyzed to see if there was a significant difference between the blended learning classroom and the more traditional classroom. STAR Math tests were administered five times throughout the year: beginning of year, fall, winter, spring, and end of year. A close to significant difference (.057) for blended learning was discovered through a Repeated Measures ANOVA. When looking at gender, a significant difference was found for girls (.049) in the blended learning setting. A further T-Test determined that a significant difference was found for the winter (.034) and end of year tests (.012) for girls specifically. Implications of these findings for blended learning, further research, and recommendations for practice are discussed.

Keywords: blended learning, technology, math

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Chapter 1

Background

"By 2020, 77% of all jobs will require some form of technological skills with more jobs

to be filled than qualified candidates" (Schuyler & Buckley, 2018, para. 2). Because of this, there

is a strong need for students to be competent using technology. Solely relying on traditional

teaching methods would not provide students with the skills needed to be ready and competitive

in the future.

Traditionally, schools have been set up with teacher-centered classrooms having all

material taught to students through direct instruction. Students performed seatwork after a

lecture with learning guided through textbooks. It was common for memorization of facts and

figures and individual practice. Traditional classrooms were known to be orderly, quiet, with

little interaction between students, and minimal computer assisted learning that would primarily

consist of visits to the computer lab. There was little room for differentiation, individualized

learning, or collaboration.

As advancements in technology and teaching practices came about, teaching and learning

had to evolve to meet the needs of 21st-century students. The shift from teacher-centered

classrooms to student-centered classrooms which focused on individual student needs as opposed

to a one-size fits all model evolved. The birth of collaborative and personalized learning helped

fulfill the needs of a more student-centered classroom. Furthermore, with the boom of

technological advancements, the students filling classrooms possessed knowledge and skills like

never before. Therefore, to fuel those needs, schools needed to deliver content with the

technology students had grown up with in the digital age. Thus, the creation of what we now

know as blended learning developed to provide students with opportunities to learn in new and
innovative ways.

As defined by Garrison and Kanuka (2004), "blended learning is the thoughtful
integration of classroom face-to-face learning with online learning experiences" (p. 96). This
definition, although simplistic, encompasses complex integration that has limitless possibilities
and applications. Thus, making blended learning a great fit for changing technologies, pedagogy,
student needs, and the importance of developing 21st century learners. Blended learning tears
down the traditional walls of teaching and has the power to tailor learning experiences for each
individual student (Giarla, 2020).

It is crucial for schools to prepare students for a future where they navigate a digital
world confidently. According to Tucker, Wycoff, & Green (2017) "Reinvention of what learning
looks like in schools and for students is what blended learning is all about, with schools that
focus on sustaining learning and innovation for all stakeholders and across all levels develop the
culture that wins out" (p. 5). Therefore, schools have to be open to evolving, growing, and
making change which involves making technology integration seamless and allowing students to
take charge of their learning in a way that builds skills that will lend themselves to a successful
future.

Blended learning lends itself to be an effective means to foster 21st-century skills in
students. Twenty-first century skills are those skills necessary to successfully navigate the
environment in which they will be living. According to Hallerman, Lewis, & Dresbach (2019)
"Educators should be inspiring creativity, encouraging collaboration, expecting and rewarding
critical thinking, and teaching children not only how to communicate, but also the power of
effective communication (para. 6)." Blended learning is the vessel to provide students with skills

and competencies they need to thrive because it has the power to fully cultivate creativity, collaboration, critical thinking, and communication.

Because building strong 21st-century learners is critical, schools must be intentional with blended learning integration. As Tucker et al. (2017) noted, "starting with the why and not the what is key" (p. 39). Preparing students for a future that has boundless possibilities is daunting, but if educators see they value in it, its effectiveness grows. Therefore, if educators see the necessity for building strong 21st-century kills in students, they will understand the why behind the need to implement blended learning.

According to Tucker, et. al. (2017), the schools that are successful are the ones that are open to change, willing to evolve to meet the needs of students, and are not stuck in their ways of doing what they have always done. Schools that are able to reinvent themselves are the ones that see success. Therefore, it is crucial for educators to understand how blended learning works, how best to navigate, and how much time should be dedicated to technology enhanced learning during class versus a more traditional learning setting, so they can make necessary changes to meet the needs of students.

Likewise, solely adding technology or creating a technology rich environment does not equate to meaningful change in a school or classroom. The critical piece is how that technology is implemented. Blended learning means that teachers use the internet to create a more personalized learning experience. It gives students more control, provides them with opportunities to discover, investigate, and become the driver of their educational experience. It affords students the prospect to have more control over time, the path that they learn, and the pace at which they learn.

Blended learning can look different in every setting. Therefore, its effectiveness must be examined in multiple scenarios. No one example of blended learning is the same. With that being said, there is a strong need to study the effects of blended learning to know if it is truly beneficial to today's learners, because it is imperative that we have prepared them to take on the challenges the future holds for all stakeholder.

Because the needs of our students change as new technologies and needed skill sets emerge, it is imperative to know if blended learning can, in fact, enhance student learning. At this time, the lack of research dealing with blended learning in the secondary and elementary schools hinders it implementation. According to Prescott, Bundschuh, Kazakoff, & Macarusoc (2018) "Research regarding the potential benefits of blended learning is limited, especially in the elementary setting" (p. 498). Without a research base, schools are apprehensive in going that direction, rush into implementation, make mistakes, and hold many misconceptions. If our students need blended learning to enhance their 21st-century skills to navigate their future, it is vital that it be studied meticulously.

This study specifically targets blended learning in a fifth grade math class. Understanding the effects of blended learning on math achievement is important for educators to see that blended learning is not just adding technology tools or going one-to-one. Similarly, it is important to see that students do not all have to be on a device simultaneously for blended learning to be effective. Further, it is key for teachers to see that they do not have to abandon "old school" or tried and trusted methods to incorporate technology. This study is critical, particularly for elementary math teachers and learning because math is thought of as a paper and pencil, hands-on centered subject. Therefore, through this study, it is vital to know if blended learning can be implemented successfully in a math classroom.

Conceptual Underpinning of the Study

It can be said that the establishment of distance learning can be traced back to Sir Isaac Pitman, the English inventor of shorthand, in 1840 (Phillips, 1998). Pitman's distance learning is a far cry to today's examples, but it is the foundation of what we now associate with blended learning. With the use of mail, Pitman was able to share his knowledge of shorthand to those that wished to learn and receive communication back from those participants. This idea caught on like wildfire much like any new form of learning.

Blended learning evolved over time. With personal computers being brought into homes and schools across the nation, the possibilities to use them for educational purposes increased. Following the availability of personal computers, the world wide web made it possible for communication across distances and to gain information like never before. Although it took some years for it to take off, this invention made the prospect for blended learning grow into what it is today.

By the mid to late 1990's, personal computers were in many homes, and beginning in 1998, the first generation of web-based instruction began (Pappas, 2015). Blended learning quickly evolved through the 2000's with new and exciting digital tools. Educators were finding that the use of technology in the classroom was just as essential as paper and pencil. Further, the student population were becoming digital natives where technology was a natural part of life. Thus, as the need to meet the necessities of today's learners was growing, it was an organic progression to have technology as the key that could meet that demand.

With that being said, blended learning, as a concept, got its start over a century ago. The need to reach learners in new ways is not a new notion. Nor is the need to grow with the ever-changing developments of technology. Blended learning has merely transformed into what we

know today. Therefore, it is critical that the effects of blended learning on academic success be studied. To make sure that educators are doing what is best for student success, gaining insight into the benefits of blended learning is essential.

Statement of the Problem

While studies of blended learning have been conducted in the past, it is still not fully known how beneficial it is in the elementary setting. The research of Unruh, Peters, & Willis (2016) shows that when pre-service teachers use a flipped model in classrooms, a display of higher levels of technology and teaching efficacy was present. At the same time, there is no evidence to show how a flipped classroom model affects student achievement.

Further research by the Evergreen Education Group (2015), showed students in a blended learning environment in the Enlarged City School District in Middletown, New York outperforming students in traditional classroom settings by 18% on the Spring 2015 NWEA MAP and MAP for Primary Grades (MPG) reading scores. Likewise, students in the blended learning classrooms outperformed peers in the traditional classroom settings by 7% on the math portion of the test. Although promising, there is still not enough known about the impact of blended learning on student achievement.

Based on research in the Randolph Central School District, math scores on state assessments in grades 3 through 8 have improved after implementing blended learning. Specifically, for third grade students that already score in the upper end of the scale, they went from 56% to 72% (Evergreen Education Group, 2015). While evidence of this relationship has been established in the Randolph Central School District, a lack of research within the public schools of Kentucky exists, in particular within the elementary schools.

When looking deeper into blended learning, it is necessary to see which, if any subgroups, benefit from a blended learning experience. It is always important to know if specific groups of students would profit from new learning strategies. One specific subgroup would be gender. According to Dang, Yulei, Ravindran, & Osmonbekvo (2016) when looking at student satisfaction and blended learning, computer self-efficacy showed a significant effect on perceived accomplishment and enjoyment for females but not for males. While this evidence can show that blended learning can influence the female students' perceived feelings and even their perceived accomplishments, further research needs to be conducted to evaluate whether blended learning has a true effect on actual learning outcomes based on gender and not merely perceived achievement and enjoyment.

Even with prior research on teacher perceptions and student achievement as whole and within specific subgroups such as gender, not enough is known. Blended learning is implemented from adult learners to children, therefore its effects must be studied for all age ranges. Additionally, blended learning is implemented with groups studying a vast array of disciplines. This also requires research for effectiveness in specific areas of learning. This is why it is so important to study blended learning's effect on math achievement in fifth grade. It needs to be understood in specific areas and age ranges.

Purpose of the Study

The overarching question guiding this study is: Does a blended learning classroom positively affect learning greater than a more traditional classroom? More specifically: (1) Is student achievement higher in fifth grade math when students are in a blended learning setting or a more traditional setting? (2) Does the implementation of blended learning affect student learning based on gender?

The hypotheses of these questions reflect the research already conducted. (1) Student achievement will be higher in fifth grade math with students in a blended learning setting over a more traditional setting. (2) Blended learning will have a greater effect on females in a blended learning environment over males.

Limitations, Assumptions, and Design Controls

Limitations to this study include a small sample size. Because only one grade level in two schools are being used, the sample is not on a large scale. Within that grade level, only math classes are being used. Therefore, information on the effects of blended learning cannot be assessed for other subject areas.

Likewise, the effects of blended learning can only be evaluated through this study for fifth grade. Therefore, the effects for other grade levels cannot be assumed. With that, it is also not known if blended learning is effective over time due to the study taking place during one school calendar year.

Additionally, the sample size is not diverse in terms of race with the population being predominantly white. Other limitations are a broad spectrum of blended learning where specific types are not being targeted. Thus, a true understanding of which form of blended learning works best cannot be determined.

Furthermore, both schools being used in the study are high achieving, where students score above grade level on the STAR Math test, as well as, score above state average on the KPREP state testing. Moreover, teachers from both schools have varied experience levels and teaching styles that might affect the outcome of the study.

Key Terms

The topic of blended learning can have many key terms that need to be defined to understand the meanings in context.

21ˢᵗ- century skills. 21ˢᵗ-century skills are used to refer to certain core competencies that will help students succeed now and in the future. These core competencies are collaboration, digital literacy, critical thinking, and problem solving (Rich, 2010).

Blended learning. Blended learning is a formal education program where a students learn partially online where content is delivered and instruction is given and partially in a brick-and-mortar location. Students also have some control over time, place, path, and/or pace of learning (Staker & Horn, 2012).

Brick and mortar school. A brick and mortar school is one that is a physical building where students attend.

Digital natives. A digital native is someone who has spent their entire lives surrounded with technology.

One-to-one classroom. A one-to-one classroom has a device available for each student in the class.

Professional Development. Professional development is learning and gaining knowledge on topics to better oneself professionally.

Professional Learning Community. A professional learning community is a group of educators that meet to communicate and collaborate to improve teaching skills and student academic performance.

Top down initiative. A top down initiative is when an idea or initiative begins with the highest person in charge and then trickles down to other stakeholders.

Traditional classroom setting. Teacher-centered delivery of instruction to students.

Summary

With the need to prepare students for a world that is different from what we know today, educators must prepare them as best they know how. If we think about it, each generation has had to prepare the next for an unknown world due to advancements. Today, technology plays an important role in our day to day life. Technology-rich work environments are becoming the norm. Students need to not only know how to navigate that environment but also be able to utilize 21st-century skills to be successful. Students must be able to work collaboratively, have strong communications skills, and be able to think critically and problem solve.

Because students are living in a different environment than those of the past with needs unlike never before, new teaching and learning methods must be introduced. Blended learning can help bridge the gap of traditional ways of instructing students with innovative methods that encourage students to take control of their learning while using tools and resources that are a part of their everyday life in this technological era. Blended learning allows for technology rich instruction and learning and development of 21st-century skills. Educators must know best practices for using blended learning and be confident in its implementation.

The remainder of this study will be divided into chapters. Chapter 2 will explore the literature on blended learning. It will explore the what, why, and approach to blended learning. Chapter 3 will explain the problem and purposes of the study and the research questions and hypotheses. The population and sample of the study will be described, as well. The data collection and instrumentation and data analysis will also be clarified. Chapter 4 will provide the results of the study while Chapter 5 will summarize the study giving conclusions, discussion, and recommendations.

Chapter 2

Introduction

With the fast-paced, technology world of today, the education realm is looking for ways to meet the needs of the students they teach. One such method, blended learning is becoming ever more popular. Teachers are tasked with preparing students for an ever-changing world filled with technology, the need for collaboration, communication, creativity, problem solving, and critical thinking. According to Patrick (2011), "Today's teachers are challenged to provide flexible, student-centered, personalized, digital curriculum using blended instructional models to meet the learners' needs and styles while engaging them and giving them more control over their learning" (p. 19). In doing this, teachers must be prepared to take on this challenge, be invested in the process, and be willing to think in ways they have never had to prior. Schools must find what is best for their student population and budget while maximizing their available resources. They must be able to work through barriers that might otherwise hinder the process.

The purpose of this research is to examine the implementation of blended learning and further identify if its utilization is beneficial to student achievement. Moreover, this study will identify if blended learning has a greater effect on the learning outcomes of both boys and girls. A deeper look into the definition of blended learning and a comparison to traditional learning will be inspected, as well as, the different faces of blended learning, the why behind blended learning, the approach to blended learning, and challenges of blended learning.

When one looks at a more traditional classroom, the teaching consists of lecture and group projects, all while students are in the same room. Teaching is also conducted either whole group or in a small group setting that is teacher led (Black, 2002). Most assignments are given to the whole class. There is little personalization, but traditional learning can be collaborative in

nature depending on the teaching style. Traditional classrooms do not incorporate blended

learning. Technology may be used in a traditional classroom but not in a blended learning sense.

Blended learning comes in many forms and can be described differently depending on the

person. Its execution can also come in many forms to tailor to specific needs of schools and

students. Blended learning can be defined in many ways but most definitions are comparable in

nature. Blended learning according to Lexico Dictionaries (n.d.) "is a style of education in which

students learn via electronics and online media as well as traditional face-to-face teaching."

Similarly, blended learning is defined as:

> "at least in part through online learning, with some element of student control over time,
>
> place, path, and/or pace; at least in part in the supervised brick-and-mortar location away
>
> from home; and the modalities along each student's learning path within a course or
>
> subject are connected to provide an integrated learning experience" (Clayton Christensen
>
> Institute, 2020, "What is blended learning?" section).

Because of the broad spectrum of the definition and the diverse approaches that can be

implemented, blended learning can come in many forms. These models of blended learning are

there to meet the diverse needs of student populations. The models include: Face-to-Face

Driver, Rotation model, Flipped Classroom, Flex model, Online lab, Self-Blended model, and

Online Driver Model. Blended learning can be achieved in one-to-one settings and settings

where only a handful of technological devices are available. They can come in forms of desktop

computers, iPads, tablets, laptops, and Chromebooks. With the vast approaches to blended

learning available, schools must find what is best for their student population and budget while

maximizing their available resources. They must be able to work through barriers that might

otherwise hinder the process. Furthermore, researchers have identified blended learning as

having potential to enhance and increase student engagement (Henrie, Bodily, Manwaring, &

Graham, 2015, p. 132). When teachers are able to keep students actively engaged, they are more

likely to be successful in their learning.

<div align="center">**Literature Review**</div>

The Many Faces of Blended Learning

To implement blended learning, above all, it must first be understood. Blended learning is

a combination of face-to-face, teacher-led instruction accompanied by digital technology. It then

uses functional data to provide students with a tailored educational route. Blended learning has

the power to move the traditional classroom of one size fits all to a more personalized approach

which allows teachers to meet the needs of students through smaller group instruction (Tucker et

al., 2017). Further, Imbriale (2013) emphasizes that "a blended classroom takes full advantage

of 21st century instructional practices but face-to-face interaction is essential" (p. 32). Therefore,

blended learning cannot be a solely online method.

Blended learning also goes by the names of hybrid learning and mixed-mode learning.

"Hybrid learning is a pedagogical approach that combines face-to-face instruction with

computer-mediated instruction" (O'Byrne & Pytash, 2015, p. 137). At its most basic level

according to W. York, Digital Learning Coach, "blended learning is learning, number one."

(personal communication, March 29, 2019). No matter the name or varying definition, at its

core, blended learning is an amalgamation of face-to-face learning and digital learning.

Because of blended learning's expansive characteristics, it can be delivered in a multitude

of ways either with only one model or a combination of models depending on the needs of the

students. The models are distinctive in their definition and use.

In the Face-to-Face Driver, a teacher delivers a majority of the curriculum in person, but provides online learning opportunities for those students that may need remediation or further support. This model uses technology to support the teacher's instruction.

The Rotation model sounds very much as it is run. Students rotate on a fixed schedule between traditional classroom instruction and a self-paced online learning setting. It can be viewed as stations where some are with a teacher and some station rotations are online. This model allows for more personalized learning where students' needs are being met through intentional planning of small group instruction and even one-on-one instruction. This model is seen often in elementary schools.

The Flipped Classroom model allows for online learning that takes place off site with teacher-guided practice or projects during the regular school day at a brick-and-mortar building. Thus, reversing or flipping what would traditionally be teacher-lead instruction at school with homework for practice.

The Flex model is more digital, independent learning with an on-site teacher there for support. This model requires students to be able to take more responsibility for their learning. It is often used for dropouts and for credit recovery. Therefore, more appropriate for an older student population.

The Online Lab is conducted in a brick and mortar school monitored by paraprofessionals but completed entirely online. It is utilized within the regular school day and often used for regular coursework. In the Self-Blend model, students conduct their learning in their brick-and-mortar school but can supplement with one or more online, distance learning classes. The last model, Online Driver involves an online learning platform and teacher. It includes optional or mandatory face-to-face check-ins with the teacher.

With the availability of so many models, schools need to understand their purpose to know which model is best for them. Oftentimes, it depends on the age of the students, the resources available, and the specific needs of the students. For elementary students W. York states, "A station rotation model is probably the best. A one size fits all; any kind of model does not work in elementary." (personal communication, March 29, 2019). According to Garrison & Kanuka (2004), "Research shows that there is no one perfect method to balance out face-to-face and online instruction in a way that is perfect in every situation (O'Byrne & Pytash, 2015, p. 139). Thus, what works for one school or classroom may not work best for another. Another crucial part of the process is to have a clear goal or vision and then be able to communicate that to all stakeholders. Moreover, experts agree that the best way to implement blended learning is to start small.

Why Blended Learning

The push for blended learning models is backed by the U.S. Department of Education. According to a 2009 U.S. Department of Education study, "Evaluation of Evidence-Based Practices in Online Learning," which found that students learn better in a blended model than they do in either fully online or traditional "brick-and-mortar" models" (McLester, 2001, p. 40). With that being said, blended learning is progressively becoming the approach of choice in the digital learning realm. Blended learning provides adult supervision when student safety is a school's utmost importance and allows for social interaction with peers to develop communication skills. With learning best occurring through social interaction, blended learning affords students the opportunity to still learn digitally while not removing the social aspect. Students are able to not only interact with peers face-to-face, but they also are allowed to take

advantage of social learning digitally. This can be accomplished through meaningful online discussion and reflection with others.

Additionally, according to Olubummo, Emmanuel, Otobo, & Bello (2019), blended learning does not put a restriction on where the learning takes place or where the materials can be accessed. Students also have the ability to repeat the learning and revisit material as many times as needed. These advantages put the control in students' hands.

With the demands of teaching 21st century learners, educators must find ways to best engage students, so they maximize their success. "The term "21st-century skills" is generally used to refer to certain core competencies such as collaboration, digital literacy, critical thinking, and problem-solving that advocates believe schools need to teach to help students thrive in today's world" (Rich, 2010, para. 1).

"Experts Michael Horn, USDLA CEO John Flores and iNACOL CEO Susan Patrick state that, blended learning offers the best of both worlds, allowing school to integrate 21st century instructional models such as time and space flexibility, self-pacing, digital content and increases personalization into an adult-supported environment" (McLester, 2011, pp. 40-41). Educators must meet the needs of diverse learners through differentiation, as well. Schools must accommodate for students that might not otherwise be privy to certain courses through their brick-and-mortar setting. Further, schools must find ways to help students attain success when they are falling behind or have their learning hindered by other obstacles. According to O'Byrne & Pytash (2015), "Much of the power of hybrid learning comes from modification or manipulation of time, space, and place, to improve teaching and learning" (p. 138). With the ability to modify and manipulate, teachers have the power to maximize the success of the learner.

When looking at research on engagement, Dzuiban et. al., (2011); Graham & Robinson, (2007); Shea & Bidjerano, (2010), has identified blended learning as having potential to enhance and increase student engagement (as cited in Henrie et al., 2015, p. 132). Although there is potential to enhance and increase engagement, it does not say definitively. As noted from the research by Henrie, et. al., (2015), "Online learning activities had both lower and higher class average DropThought scores than face-to-face activities. Clearly, the design of the activity matters more than the medium" (p. 147). With that being said, just using the technology does not guarantee engagement. The design of the lesson or activity has more merit in regards to engagement.

The most important piece to the learning puzzle is the teacher. A teacher that plans and designs lessons that focuses on the learning outcome is crucial. Using a technology tool for the sake of using technology is not instant engagement. "The presence of technology does not equate to meaningful use or impact in the classroom. A thoughtful approach to the specific technology chosen and how it is deployed is critical" (Tucker et al., 2017, p. 28).

Another challenge educators face is the demands of differentiation. Educators are faced with finding ways to differentiate for learners at different levels. Many have turned to a blended approach because it gives them the ability to manipulate time. Blended learning affords teachers opportunities to work with small groups while others are engaged in online learning. According to Barshay (2011), "Advocates of blended learning say it holds the promise of offering engaging, individualized computer instruction that allows children to move at their own pace" (p.1). Additionally, computers preserve the small-group instruction that is considered critical for student success (p. 2). Further, W. York explains, "The more you can split those groups up and work with small groups of students the better it is for their learning, but also for you to

differentiate what each group needs." (personal communication, March 29, 2019). With the addition of blended learning programs, the results have been increased collaboration, more personal time with the teacher, and motivated 5th graders tackling college-level math concepts (McLester, 2011, p. 46).

Blended learning also comes into play when students attend schools that cannot offer specific courses. This allows students the opportunity to take a course that might otherwise not be possible. According to Horn and Staker (2011), "Blended learning increases advanced level course options through online learning in high schools" (as cited in Patrick, 2011, p. 23). Likewise, with budget constraints that many schools face today, digital learning opportunities expand options for students, elevate access to high-quality teaching, and allow for flexibility-while concurrently personalizing instruction and delivering teachers with an abundance of sound data.

As for students that do not fit into the traditional mold of a "brick-and-mortar" scholar, blended learning allows them to continue their studies. Students that need credit recovery or drop-out recovery fit into this category. These students benefit best from the Flex Model where they receive a vast majority of their instruction online while still being provided on-site teacher support. Furthermore, programs such as Diploma Plus allow for competency-based learning for over-age, under-credit and off-track students. Blended learning allows students to have individualized learning plans where they are involved in multiple models such as Face-to-face driver and buffet. According to Patrick (2011), student graduation rates far exceed comparable schools with similar demographics (p. 23).

The Approach to Blended Learning

As mentioned previously, the blended learning approach is different for everyone because there is not a "one-size fits all" method. With that being said, to implement a blended learning environment, many factors need to be taken into consideration by all. There needs to be a vision, buy-in, support, proper professional development, a cultivation of a coaching culture, and empowered PLCs. As Tucker and Umphrey emphasized (2013) "For school leaders to support blended learning and encourage teachers to use it, they must have a common understanding of what it is" (p. 37). Teachers must know the what and the why to make it a beneficial approach to teaching and learning.

"Simply adding technology to instruction does not mean that all learners will be motivated or engaged" (O'Byrne & Pytash, 2015, p. 138). Before even purchasing devices, there needs to be a purpose or vision. Culatta (2019) states that "schools need a clear vision for learning before jumping into buying devices or software" (p. 27). Additionally, "for districts considering implementing or ramping up a blended learning program, the place to start is with goals" (McLester, 2011, p. 42). The purpose should not just be understood by administrations, but the entire school community must understand. Therefore, starting with a plan and purpose will gain support and enthusiasm.

Once a vision is established, buy-in or creating a spark is necessary. Without buy-in, blended learning is just another top-down initiative. Tucker (2019) believes that "teachers are more likely to buy in, take risks, and champion an initiative if leaders can get them excited" (p. 57). When teachers are excited and take ownership of initiatives, the likelihood of success increases.

When teachers are sold on blended learning, they must then be supported. Without the support, the spark can diminish. Tucker (2019) states that "teachers resent having devices in their classrooms that they do not know how to use" (p. 56). Teachers need to know how to use the devices purposefully. "If devices are not used purposefully, they can quickly become a distraction" (Tucker, 2019, p. 56). To emphasize the point of support, principals must be the model. W. York emphasizes, "You've got to have that admin support." (personal communication, March 29, 2019). They must dive into the initiative and be willing to lead the way for blended learning to become systematic in a school.

With support comes meaningful professional development. According to Tucker (2019), "The traditional approach to professional development, in which large groups of teachers are mandated to attend a handful of presentations or workshops throughout the year, isn't effective in an era of hyper connectivity and rapid technology change" (p. 57). "What teachers need most isn't training on particular tools, but training that bolsters their own confidence in their creative ability to work with continual technological change in the classroom" (Mehta, Henriksen, & Rosenberg, 2019, p. 65). Additionally, Mehta et. al (2019) believes that, "teachers need to develop a creatively focused, technology fluent" (CFTF) mindset (p. 65). Further, teachers need time to explore and play to develop their understanding and learning.

To further the impact of professional development, teachers must put the learning into practice. There must be a follow-up. Tucker (2019) states, "Teachers need support during implementation, and coaches are the bridge between training and implementation" (p. 58). "It will not work without the principal support and then with that principal support and either a digital learning coach or instructional coach or just an assistant principal, you've got to have a coaching model." (W. York, personal communication, March 29, 2019). Teachers need to be

able to co-create lessons, co-teach, be provided models, and have the ability to reflect with a

coach. In reference to coaches, W. York says, "You've got to be able to go in a classroom, model

what you want it to look like, co-teach with teachers." (personal communication, March 29,

2019). For blended learning to be effective, teachers need to be afforded the opportunity to learn

while doing.

During this time of implementation, teachers need support from one another. This can be

accomplished through professional learning communities or PLCs. PLCs are a time for sharing

best practices, identifying growth areas, finding strategies to meet those areas, deep discussion

about what their students are teaching them, analyzing student data, and challenging one another

to keep growing in their professional practice. Through PLCs, teachers implementing blended

learning can support and help one another grow in this endeavor. Additionally, if the culture is

right, teachers can get support from each other through coaching. If there is a culture of trust and

a growth mindset shared by all, teachers can help each other become better blended learning

teachers. W. York mentions, "They'll help each other. Teachers need someone to go to for help

and bounce ideas off of from someone who knows what that looks like." (personal

communication, March 29, 2019).

Challenges of Blended Learning

As with many new initiatives, there are always barriers that must be tackled. The biggest

barrier is the constant need to always feel like we must fix education. Because of this, new

initiatives are put in place without any forethought and therefore most likely fail. Instead of

trying to get a quick fix, we must be more intentional with instructional practices (Kieschnick,

2017). "Technology in itself—even the most up to date, high-speed Internet-enabled kind—

changes very little in a school (Rodberg, 2019, p.75). There needs to be a why with a deliberate

plan in place.

Additional barriers exist. One such barrier according to Patrick (2011) is seat-time

policies. These are the single biggest barrier for online and blended learning" (p. 24). Moreover,

"funding should not be based on minutes in a seat, but instead aligned with competency based

policies to support and incentivize individual student growth and performance" (p. 24). Schools

feel like they can't afford the technology, but adjustments could be made to make it possible.

Money from budgets can be restructured in ways that allow for the change. Money could be

shifted from textbooks and paper to digital resources and training. Being willing to make

changes can combat these funding challenges.

Furthermore, for an initiative like blended learning to work, there must be backing from

administration in place. A lack of support from administration is a major barrier to the success of

blended learning. "Without an admin on board, you just might as well not start." (W. York,

personal communication, March 29, 2019).   Just like any new program, without the proper

supports, the initiative is doomed to fail.

An unclear focus can be detrimental. "Many blended learning models fall flat because the

focus was on the technology and not on the instructional strategies, pedagogy, and academic

goals that teachers apply to instruction" (Kieschnick, 2017, p. 7). This goes back to having a

clear and focused plan with training in place. W. York states that "people think that when they

go one-to-one, it's blended learning." (personal communication, March 29, 2019). Devices do

not equate to blended learning. W. York further explains, "Because we have given everyone a

device, we're doing blended learning. You're not necessarily doing that; you've just bought a

bunch of devices." When schools aren't truly knowledgeable about blended learning, roadblocks

occur.

As with any initiative, there will always be roadblocks that take time, creativity,

ingenuity, and a mind shift to overcome.   Educators need to be patient and take it slow to make

the initiative successful. "Take your time and just remember that good technology instruction,

good blended learning is just good instruction." (W. York, personal communication, March 29,

2019)

To summarize, blended learning has the power to enhance learning. It is not the tool, or

the amount of devices available but how those tools and devices are utilized in a blended setting

to make learning more meaningful, engaging, and impactful. It also lends itself to different

learning environments to meet a variety of learners' needs while providing opportunities to grow

21st-century skills. And although there may be challenges, there are also solutions to make it

successful for students.   "Blended learning can and should elevate, not diminish, what you do

best" (Kieschnick, 2017, pg. 19).

Chapter 3

Introduction

To understand if blended learning is effective in elementary schools, it must be

implemented and the results of that implementation must be analyzed. With blended learning

being the go-to for many schools to help prepare students for their future, it is imperative that its

value be understood for classrooms as a whole and for subgroups such as gender.

For this particular study, we looked at two classrooms within the same school district but

located at separate schools that were using different approaches to teaching and learning. One

classroom used blended learning which will be known as Classroom A. The teacher in

Classroom A utilized mixed models of blended learning throughout the year depending on the needs of the students. A mixture of Face-to-Face Driver and Rotation model was implemented. The second classroom used a traditional method of teaching and learning, which will be called Classroom B. Classroom B had minimal technology usage. The teacher in Classroom B did provided some collaborative learning but would be classified as a more traditional delivery. Both are fifth grade classrooms studying math.

The research questions being posed deal with the effects of blended learning. (1) Is student achievement higher in fifth grade math when students are in a blended learning setting or a more traditional setting? (2) Does the implementation of blended learning affect student learning based on gender?

The hypotheses of these questions reflect the research already conducted. (1) Student achievement will be higher in fifth grade math with students in a blended learning setting over a more traditional setting. (2) Blended learning will have a greater effect on females in a blended learning environment over males.

Population and Sample

The school district used in the study was rural in nature. The population of the district, the two schools, and the classrooms can be found in Table 1. Within the district, the two schools used were the most similar in terms of enrollment and student demographics. Additionally, when looking at class sizes, both Classroom A and Classroom B were the most closely related within the school district.

Table 1

Population for District, Schools, & Classrooms

	District	School		Classroom	
		A	B	A	B
Enrollment	4,037	301	254	39	35
Males	2,072	154	131	19	13
Females	1,965	147	123	20	22
Excluding white not Hispanic	12.61%	5.98%	11.81%	15.2%	20%

Data Collection and Instrumentation

This study implemented a mixed methods approach with survey data from Classroom A and Classroom B math teachers and quantitative data from student assessment scores. The assessment tool used was the Math STAR assessment from Renaissance.

A survey was sent to the two participating teachers from Classroom A and Classroom B which can be found in Appendix A. This survey asked the teachers questions pertaining to gender, age range, highest level of education completed, and years of experience. It also had the teacher participants rate their level of digital skills from Novice to Expert and their familiarity with blended learning from not at all familiar to extremely familiar. Questions pertaining to their math classes were also asked. Teachers were asked how many minutes did a math period last and how many of those minutes incorporated technology? A final question asked them to share any questions they still had pertaining to blended learning.

The answers to these questions could have a possible effect on outcomes of student learning in both settings, therefore they are important to discuss when evaluating the results of the study.

As a teacher's experience in the classroom, experience with technology, education level achieved could positively or negatively affect learning outcomes in students based solely on that experience.

The STAR math assessment was used to collect data on students' math scores and growth five times throughout the school year. The average student Scale Score was used for the beginning of the year, fall, winter, spring and end of year. The Scale Score (SS) is a very useful tool to compare student performance over time and scores range from 0-1400. Both schools had a district window to complete the STAR test, therefore, each testing period is within a two-week window.

According to Renaissance Learning, Inc. (2013), the STAR Math test is a research-based assessment with 65 total research publications and 21 independent research publications. Additionally, the STAR Math assessment is a measure of a broad range of math skills with a wide range of correlations between scores of other achievement tests, diagnostic tests, and accountability tests (Renaissance Learning, Inc., 2013, p. 25). Furthermore, the KPREP assessment results were found to have a moderate to strong correlation with the STAR Math assessment.

By using the STAR Math assessment's data for math, and analyzing the survey results, the research questions can be answered and the hypothesis can be tested. By using a mixed method data, results would answer the research questions: (1) Is student achievement higher in fifth grade math when students are in a blended learning setting or a more traditional setting? (2) Does the implementation of blended learning affect student learning based on gender?

Data Analysis

STAR Math data was analyzed by using the Scale Score, comparing growth from one test period to the next throughout the course of the year. This determined if there was a significant difference between Classroom A and Classroom B. A repeated measures ANOVA was used to

look at individual student data over time comparing student achievement in the blended learning environment and the more traditional environment.

Further analysis completed with STAR Math Scale Scores to determine if blended learning had an effect on learning based on gender. A Repeated measures ANOVA with setting as the between-subjects factor was conducted using only boys. Likewise, a Repeated measures ANOVA, selecting only girls, with settings as a the between-subjects factor was conducted. Lastly, follow up t-tests, based on Repeated measures ANOVA results, were run to discover if there were significant differences between Classroom A and Classroom B.

Summary

By using a sample from two schools in the same district and focusing on one grade level and subject, the effects of blended learning on student achievement can be seen through this focused lens. Likewise, the two sample schools have similar student population when comparing two schools within the same school district. Furthermore, both schools are in rural settings with similar enrollment. Because both schools were located in the same district and state, the use of the same data collection tool, STAR Math, allowed for the ability to obtain a clear comparison.

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Chapter 4

</div>

The purpose of this study was to determine if (1) student achievement was higher in fifth grade math when students were in a blended learning setting or a more traditional setting? Furthermore, (2) did the implementation of blended learning affect student learning based on gender? The results of the study answered two questions. The first part of the analysis determined if a blended learning environment had a significant difference than a traditional learning environment through the Repeated Measures Analysis of Variance (ANOVA). The second part focused on the effects of blended learning based on gender through a Repeated

Measures ANOVA, for each gender. T-tests were conducted if necessary and in this case, a

follow up t-test was conducted with only the girls.

Findings

The sample for blended learning (N=39) and traditional (N=35) completed the STAR

Math test five times throughout the year (Beginning of Year, Fall, Winter, Spring, End of Year)

with their results located in Table 2. For both blended learning and traditional, growth was seen

through the year.

Table 2

STAR Math results for blended learning environment and traditional environment

Testing Time	Setting	M	SD	N
Beginning of Year	Blended Learning	689.79	64.856	39
	Traditional	678.94	62.943	35
Fall	Blended Learning	734.10	61.729	39
	Traditional	705.51	73.837	35
Winter	Blended Learning	759.15	59.764	39
	Traditional	726.54	69.589	35
Spring	Blended Learning	767.51	66.393	39
	Traditional	743.46	73.201	35
End of Year	Blended Learning	778.64	58.841	39
	Traditional	741.86	75.294	35

The results of the repeated measures ANOVA indicated there was not a significant

difference, but the data did indicate close to significance in student achievement between a

blended learning environment and a traditional environment with p (.057) $> \alpha$ (0.05). The effect

of blended learning on student achievement showed a close to significant difference F (1,72) =

3.751, p= .057.

The results for gender analysis for achievement in blended learning were assessed at each

testing period. Test results for each testing period for the blended learning environment and

traditional environment in regards to gender can be found in Table 3. Student growth for boys in

the blended learning environment (N = 19), increased at every testing period. Likewise, growth

for girls in the blended learning environment (N = 20), increased each time. Boys (N = 13) in

the traditional environment also saw growth at each testing period. While girls (N = 22) in the

traditional environment grew at all testing period except End of Year with a drop from (M =

735.18) in the Spring to (M = 728.86) at the End of Year tests.

Table 3

STAR Math Scores by Gender

Testing Time	Setting	Gender	M	SD	N
Beginning of Year	Blended Learning	Boys	690.68	83.293	19
		Girls	688.95	42.877	20
	Traditional	Boys	688.54	59.152	13
		Girls	673.27	65.760	22
Fall	Blended Learning	Boys	742.95	75.730	19
		Girls	725.70	45.112	20
	Traditional	Boys	730.08	65.360	13
		Girls	691.00	76.102	22
Winter	Blended Learning	Boys	768.00	78.914	19
		Girls	750.75	33.034	20
	Traditional	Boys	749.46	61.358	13
		Girls	713.00	71.916	22
Spring	Blended Learning	Boys	778.79	84.994	19
		Girls	756.80	41.526	20
	Traditional	Boys	757.46	90.101	13
		Girls	735.18	61.994	22
	Blended Learning	Boys	779.21	73.170	19

Testing Time	Setting	Gender	M	SD	N
End of Year		Girls	778.10	43.032	20
	Traditional	Boys	763.85	73.942	13
		Girls	728.86	74.687	22

To look further into whether blended learning affects achievement on specific genders, boys were tested first. A Repeated measures ANOVA with setting as a the between-subjects factor was performed which resulted in close to significant difference for boys in a blended learning environment with $F(1,30) = .330$, $p = .057$. Because the results were only a close significance, further testing was not necessary.

The same Repeated measures ANOVA with setting as the between-subject factor was conducted for only girls. The result showed a significant difference for girls in a blended learning setting with $F(1,40) = 4.115$, $p = .049$.

Because there was a significant difference for girls, a T-test was conducted to test for significant differences at each testing period. Results varied throughout the school year. At the beginning of the year, there was no significant difference for blended learning girls ($M = 688.95$) and traditional girls ($M = 673.27$), $t(40) = .12$, $p = .371$. For the fall test, there was no significant difference for blended learning girls ($M = 725.70$) and traditional girls (691.00), $t(40) = .15$, $p = .084$. The winter test results showed a significant difference for blended learning girls ($M = 750.75$) and traditional girls ($M = 713.00$), $t(30.09) = .004$, $p = .034$. Results for the spring test indicated no significant difference for blended learning girls ($M = 756.80$) and traditional girls ($M = 735.18$), $t(36.91) = .035$, $p = .189$. Results showing for the end of the year test for blended learning girls ($M = 778.10$) and traditional girls ($M = 728.86$), $t(34.11) = .009$, $p = .012$ indicated a significant difference. Therefore, a significant difference was found during the

winter and end of year tests for girls in a blended learning setting and no significant difference was found at the beginning of the year, fall, and spring.

In regards to the teacher survey conducted, both teachers were female. The age range for Teacher A in the blended learning environment was 30-34 while Teacher B in the traditional environment was 45-49. Teacher A reported the highest level of education is a Master's Degree with 10 years of experience while Teacher B has earned multiple Master's Degrees with 25 years of experience teaching. When asked about levels of digital skills, Teacher A reported being at a 4 on 1-5 scale ranging from Novice to Expert while Teacher B reported being at a 3 on the same scale. As for familiarity with blended learning at the end of the school year, Teacher A reported a 4 on a 1-5 scale of Not at all familiar to Extremely familiar. Teacher B reported a 2 on the same scale. When looking at class period length, Teacher A responded that a math period lasts 55 minutes while Teacher B reported a 60-minute math period. In the class period, Teacher A reported that 30 of the 55 minutes was dedicated to incorporating technology. As for Teacher B, 10 of the 60-minute class period incorporated technology. When looking at the findings from the survey, the demographics of the teachers did not make a clear difference in the outcomes.

Chapter 5

Conclusions

This study served to investigate the effects of blended learning on student achievement. More specifically, it further investigated (1) if student achievement was higher in fifth grade math when students were in a blended learning setting or a more traditional setting and (2) did the implementation of blended learning affect student learning based on gender.

Hypothesis (1) was not supported fully. Results from the analysis of data returned a result that showed blended learning did not have a significant difference on student achievement $p = .057$ but were close enough to warrant consideration.

Hypothesis (2) blended learning will have a greater effect on females in a blended learning environment over males was found to be significant but with remaining questions. The results for the subgroup gender and the effects of blended learning on achievement did yield mixed findings. Although there was no significant difference for boys $p = 0.57,$ the results were close to $\alpha < .05$. As for girls, results varied through the testing periods. A significant difference was found at the Winter ($p = .034$) and End of Year ($p = .012$) testing times but not at the Beginning of Year ($p = .124$), Fall ($p = .149$), or Spring($p = .189$). The results show that at mid-year and end of year, blended learning did have a significant effect on achievement in math for girls.

Understanding the effectiveness of blended learning is critical in our day in age. Students today are digital natives. Teachers need to find ways to meet them where they are and best prepare them for a world that doesn't even exist yet. Blended learning provides opportunities for students to learn face-to-face in a "brick-and-mortar" setting, as well as, online. Blended learning allows students to use 21st century skills that so many students today are lacking. It also allows students that might otherwise fall to the wayside, to reach their fullest potential.

Based on the analysis of STAR Math Scale Scores and review of literature, effects of blended learning on student achievement conclusions can be drawn. Further discussion, considerations, and recommendations regarding blended learning and its effects will be offered.

Discussions

Regardless of the evidence in the study that indicates no significant effect of blended learning on student achievement, the findings were close to significance. Since the findings for blended learning have close to significance, it does reflect the prior studies discussed. Further, test results for the blended learning class scored higher at each test period than the traditional class which could give credit to the effectiveness of blended learning.

Likewise, the results of the effects of blended learning on gender does support the fact that blended learning can be effective, specifically for subgroups like girls. Although the results for testing periods were not consistent, by the end of the year, there was a significant difference for girls in the blended learning settings.

Further, specific limitations could have affected the results. For example, the sample size is small and with a larger sample, the results could be different. Additionally, the teacher in the traditional classroom has more years of experience and a higher education level achieved. These survey facts could affect the results, as well. Not only could experience and education level be a factor, but also teaching styles. At the same time, neither teacher was completely proficient in implementing blended learning. Although the blended learning teacher had previous learning and administration support, true effective implementation takes time to reflect and make adjustments along the way over time.

Recommendations

Recommendations for Further Study

Blended learning and its effects on student achievement is a topic that warrants further research. The research was limited to only math in one grade level at two schools for one year. Therefore, studies with larger sample sizes would be recommended, as well as, studies with

longitudinal data that spans more than one year. Longitudinal data would allow for teacher

development and growth in the implementation of blended learning, as well as, student comfort

level with technology and one-to-one use. With that being said, further research could collect

data on teacher and student comfort level at the beginning and end of the study to compare with

test score data. Additional study would also be helpful across subject areas to gain a better

understanding, as well as, throughout various subgroups to help target needs for specific student

populations.

Recommendations for Practice

Since we are immersed in a digital world, teachers and students alike should feel

confident in using technology in learning in a way that supports 21st century learning skills.

Also, due to the demands of preparing students for a workforce that will likely request

proficiency in technology, it is the duty of the education system to make sure students are ready

and prepared. There are many approaches the education system could take to make this happen.

Blended learning can be effective if all stakeholders understand the why behind the

implementation. When new initiative begins with the why, buy-in is much more probable.

When teachers buy-in to the focus on making sure they are providing what is best for 21st-

century learners through the implementation of blended learning, the want and desire to

implement with fidelity will be achieved.

Additionally, teachers must be trained and supported while being provided opportunities

to gain confidence in blended learning. Opportunities for coaching throughout the process are

necessary and collaboration with colleagues is a must. Teachers need to know that reflection is

key, and it is okay to fail forward. To make blended learning work, it must be a team effort.

Furthermore, it takes time. Implementing blended learning overnight is not the answer. A clear and focused plan with full transparency will make all the difference. Also, it is essential to start small. It is important to know it is okay to make changes along the way because blended learning does not look the same everywhere. When blended learning is fine tuned for each classroom and school, the benefits can be significant. Tackling blended learning in this manner allows schools to gain proficiency, comfort, and confidence. Then it will easier to build upon the successes already established.

It is important to note that like many new initiatives there are barriers or roadblocks that should be addressed. Policies, budgets, lack of teacher training, support, coaching, and minimal research in the secondary and elementary levels impede the execution of blended learning fully. These roadblocks can exist and that is okay. Go into blended learning implementation with the full understanding these barriers must be taken into consideration and do what it takes to break them down. Again, taking it slowly and being "all in" helps to alleviate these barriers.

Summary

The vast majority of the literature evidence supports the hypotheses of this paper (1) Student achievement will be higher in fifth grade math with students in a blended learning setting over a more traditional setting and (2) Blended learning will have a greater effect on females in a blended learning environment over males. Because the data analysis of the hypothesis (1) was close to being significant, it is warranted to be considered. As for hypothesis (2), blended learning did have a greater effect of girls' learning over boys as seen in the data analysis. Although the results were not consistent for each testing period, girls did see a significant difference at the Winter and End of year tests which also warrants consideration.

It has been expressed in the literature that by utilizing blended learning, teachers are able to provide students with a challenging and rigorous learning environment that prepares them for their future.   Conversely, because blended learning is in its infancy, and there is a lack of an array of research, additional and specific research is needed to further understand the benefits to K-12 schools. Research that dives into the effects of blended learning on student success based on measurable data from test scores pre and post blended learning for larger sample sizes and diverse subject areas. Longitudinal data also is necessary to see the lasting effects of blended learning are critical, as well. This may provide a clearer view on the true effects of blended learning.

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Appendix I

Teacher Survey

1. Email Address:

2. Gender:
    o   Female
    o   Male

3. Age Range
    o   20-24
    o   25-29
    o   30-34
    o   35-39
    o   40-44
    o   45-49
    o   50-59
    o   60-64
    o   65-69

4. Highest Level of Education Completed
    o   Bachelor's Degree
    o   Master's Degree
    o   Multiple Master's Degrees
    o   Doctoral Degree

5. As of the end of the 2018-2019 school year, how many years of experience do you have?

6. Identify your level of digital skills

	1	2	3	4	5	
Novice	o	o	o	o	o	Expert

7. By the end of the 2018-2019 school year, how familiar were you with blended learning?

	1	2	3	4	5	
Not at all familiar	o	o	o	o	o	Extremely familiar

8. How many minutes did a math period last?

9. How many of those minutes did you incorporate technology?

10. What questions do you still have pertaining to blended learning?

Appendix II

MURRAY STATE UNIVERSITY
CONSENT TO BE PART OF A RESEARCH STUDY

NAME OF STUDY AND RESEARCHERS

Title of Project: Blended Learning Versus Traditional Learning

Principal Investigator: Dana Dowdy

GENERAL INFORMATION

I am currently doing a research study to learn more about blended learning in the classroom. To get information about levels of blended learning understand, use, and teaching experience, I would like two people to answer a survey. It is expected it to take about five minutes to complete the survey.

Answering this survey is voluntary. You don't have to answer it if you'd rather not. You can skip any questions that you don't want to answer, whatever the reason, and you don't have to tell why.

It's possible that some of the questions may make you feel uncomfortable. If a question makes you uncomfortable, you can just skip it and go to the next question.

To keep your information confidential, your name will not be used when providing information about demographics of the school or grade-level or teacher background and experience. School names will also not be used. There will be no personal information that could reveal who answered the survey in the published study.

Answering the survey won't benefit you directly and there is no compensation for participation.

CONTACT INFORMATION

To find out more about the research, to ask a question or express a concern about the research, or to talk about any problems you may have, you may contact the following:

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