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ONE DISTRICT’S STAKEHOLDERS’ DESCRIPTIONS OF THE SUPPORTS AND BARRIERS IMPACTING THE USE OF A DIGITAL MATHEMATICS CURRICULUM

Andrew R. Mills
Northern Michigan University, amills@nmu.edu

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By:

Andrew R. Mills

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This thesis by Andrew Mills is recommended for approval by the student's Thesis Committee and Department Head in the School of Education, Leadership, and Public Service and by the Assistant Provost of Graduate Education and Research.

Derek Anderson 6/18/2020
Committee Chair: Derek Anderson, Ed.D. Date

Stephen Smith 6/18/2020
First Reader: Stephen Smith, Ph.D Date

Kenneth Holder 6/18/2020
Second Reader: Kenneth Holder, Ph.D. Date

Joe Lubig 6/18/2020
Department Head: Joe Lubig, Ed.D. Date

Lisa Eckert 8/14/20
Lisa Eckert, Ph.D. Date
Dean of Graduate Education and Research

ABSTRACT

ONE DISTRICT'S STAKEHOLDERS' DESCRIPTIONS OF THE SUPPORTS AND BARRIERS IMPACTING THE USE OF A DIGITAL MATHEMATICS CURRICULUM

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Digital Curriculum Resources are a new, fast-growing educational technology for learning mathematics that can allow today's classroom to be transformed instantaneously. More efficient technology, however, does not necessarily equate to increased student achievement. To ensure that these technologies benefit their learners, it will become critical for schools to identify potential barriers and develop plans for addressing these barriers during implementation. This qualitative case study sought to better understand the experiences of various stakeholder groups at a suburban middle school that has used a digital mathematics curriculum for the last two school years. Using an interview protocol, two administrators, five teachers, 10 students, and 15 parents were interviewed about their experience using a digital curriculum. Data were electronically transcribed, coded, and categorized for analysis. Overall, responses were more negative than positive regarding their experience using a digital curriculum. Administrators identified numerous barriers with teachers and students negatively impacting use of a digital curriculum. Teachers were more critical than supportive of the curriculum and suggested the curriculum may not fit the needs of the community. Students expressed mixed feelings regarding the curriculum identifying multiple benefits and barriers. Parents reported a lack of connection to the digital curriculum. Additionally, teachers and students identified the digital device as a significant distraction to the learning process and multiple groups identified significant training needs for staff, students, and parents.

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CHAPTER 1: INTRODUCTION

For the last twenty years, computer and information technology has been one of the fastest growing industries in our country (Csorny, 2013; Hatlevik, 2017). The rapid advancement of technology has not only affected the growth of careers in this field but also opened an entirely new world of learning for the students preparing to join the country's workforce (Al-Bataineh et al., 2008). Technology has allowed today's mathematics classrooms to be transformed instantaneously, providing learning opportunities to students that were never possible before. Raymond (2016) stated technology allows instruction to "be catered to the student's specific needs; meaning that if a learner has sufficient understanding in one area, they can move on to the next topic" (p. 4). This means that instruction can be tailored to fit the specific needs of individual students and any problems with learning can be addressed without holding back the learning of others. In addition, instructional technology provides teachers with a way to increase their efficiency with teacher-related tasks (Corkin et al., 2016). Rather than collecting the handouts from each student, teachers can view students' work in real time, providing almost instantaneous feedback, and constantly monitoring the learning in progress.

Statement of the Problem

Digital Curriculum Resources (DCR) are a new, fast-growing educational technology for learning mathematics. Most DCR incorporate the use of videos and animations to introduce and extend topics of study. The use of multimedia is designed to be more engaging for learners, hooking them into the subsequent learning tasks (Pepin et al., 2017). Historically, mathematics has been taught by presenting specific topics in various forms. Language serves to introduce and contextualize the content, images furnish a general overview of the content and its relations, and symbolism is used to determine results (O'Halloran et al., 2018). DCR claims to extend and improve these traditional forms by increasing the connectivity between them. Learners can engage with multimedia that visually and symbolically highlights important content, while simultaneously provided with access to related vocabulary and examples (O'Halloran et al., 2018).

The increasing availability of DCR for teaching K-12 mathematics may be exciting to some, yet the strengths and weaknesses of DCR are not yet fully understood (O'Halloran et al., 2018; Pepin et al., 2017). Previous research has identified that any form of technology integration in education comes with challenges (Camilleri, 2016; Ertmer, 1999; Ertmer, 2005; Hsu, 2016; Makki et al., 2018). Barriers exist, both intrinsic and extrinsic, for effectively utilizing instructional technology to promote learning and achievement. Additional research is needed on the barriers to the implementation of digital curricula as the primary method of instruction.

Purpose of the Study

Schools continue to expand their use of DCR technology as part of the learning process, but more efficient technology does not necessarily equate to increased student achievement. Factors such as cost, availability, time, support, and self-efficacy play a key role in the effectiveness of DCR technology as a learning tool. To ensure that DCR benefit their learners, it will become critical for schools to identify potential barriers and develop plans for addressing these barriers during implementation. This will be especially true for schools considering a digital curriculum as their primary program for instruction. A need exists for additional research that explores how these new digital curriculum programs are being used and how various stakeholder groups describe their experiences regarding its use.

The purpose of this study was to better understand the experiences of various stakeholder groups using a digital curriculum for learning mathematics by attempting to answer the following question: How do one district's stakeholders describe the supports and barriers to usage of a digital mathematics curriculum? The following sub-questions guided the collection and analysis of data: (a) How do one district's administrators describe the supports and barriers to usage of a digital mathematics curriculum? (b) How do one district's teachers describe the supports and barriers to usage of a digital mathematics curriculum? (c) How do one district's students describe the supports and barriers to usage of a digital mathematics curriculum? (d) How do one district's parents describe the supports and barriers to usage of a digital mathematics curriculum?

Theoretical Framework

Three theoretical frameworks were used for conceptualizing the context and barriers impacting the implementation of a digital curriculum as the primary method of instructional delivery. *Digital Typology,* created by Choppin et al. (2014), outlines three distinct areas to explore when analyzing DCR: the potential to change students' learning experiences, flexibility for teachers when designing lessons and sequencing content, and availability of rapid and automatic assessment and reporting. *Digital Typology* "conceptualizes the learning space in terms of learning experiences, differentiation/individualization, social/collective features" (Pepin et al., 2017, p. 647). *Digital Typology* provides a framework to explain stakeholders' descriptions of their experiences with a digital curriculum for learning mathematics.

Mezirow's (1997) *Transformative Learning Theory* provides the assumption that, in lay terms, every individual has their own unique view of the world based upon their personal life experiences. Individuals develop a "coherent body of experience—associations, concepts, values, feelings, conditioned responses—frames of reference that define their life world" (Mezirow, 1997, p.5). The frames of reference often guide whether a new idea is accepted or rejected. In order for transformative learning to occur, individuals must reflect upon their assumptions and the assumptions of others. *Transformative Learning Theory* provides a framework to explain the interaction of external and internal factors that may influence stakeholders' perceptions of and use of a digital curriculum.

Diffusion of Innovation Theory (Rogers, 1962) describes barriers to innovation adoption. Rogers (2003) identified that there are five characteristics that impact the diffusion of an innovation: relative advantage, compatibility, complexity, observability, and triability. "As each of these increases, it is hypothesized that the rate of adoption will increase (with the exception of complexity, for which a decrease is hypothesized to increase the rate of adoption)" (Lundblad, 2003, p. 52). *Diffusion of Innovation Theory* contextualizes the foregrounding, or background, to stakeholder descriptions of their experiences with a digital curriculum for learning mathematics.

Definitions of Important Terms

Compatibility – the measure of how well the innovation aligns with the experiences and needs of the people adopting and using it (Rogers, 1995).

Complexity – the ease of understanding and using an innovation (Rogers, 1995).

Digital Curriculum Resources (DCR) – organized systems of resources in digital format that articulate a scope and sequence of curricular content (Pepin et al., 2017).

Digital Technology - the branch of scientific or engineering knowledge that deals with the creation and practical use of digital or computerized devices, methods, systems, etc. (Digital Technology, n.d.).

First-order barriers – Barriers extrinsic, or external, to the teacher and/or learner. These include lack of access to computers and software, insufficient time to plan instruction, and inadequate technical and administrative support (Ertmer, 1999).

Observability – how visible an innovation is to others (Rogers, 1995).

Relative advantage – the perceived benefit an innovation, or digital curriculum, will have over the existing system (Rogers, 1995).

Second-order barriers – Barriers that are intrinsic, or internal, to the teacher and/or learner. These include beliefs about computers, established classroom practices, and unwillingness to change (Ertmer, 1999).

Technology – the practical application of knowledge especially in a particular area (technology, n.d.).

Triability – the degree to which the innovation adopter can experiment with the innovation before implementing (Rogers, 1995).

Limitations and Delimitations

There are limitations and delimitations to this study. The scope of this study is limited to research at only one school in one school district and therefore, the results may not be applicable to similar contexts. Another limitation of the study is that the researcher is a mathematics teacher at the school used in the study. The perspective of the researcher and any potential biases he possesses could influence the results of the study. There is also the possibility that participants' professional relationship with the researcher could influence their responses during interviews. It is possible that the data collected could have varied if the researcher was not a member of the school community.

The research site used for this study was selected through purposive sampling to ensure that a school was selected that currently uses a digital curriculum for math instruction. As such, this sampling technique presents limitations to the results and generalizability of the study. The risk of selecting a site using this method is obtaining data that is not reflective of the larger population (Jones & Knotter, 2006).

The study was designed and implemented entirely by the researcher, yet it is important to note that members of the school were aware of the research. Therefore, it is possible that the results of the study are not generalizable to other academic institutions using a digital curriculum.

The school participating in this thesis research included principals, assistant principals, and general education teachers. Due to the focus on students in general across the school, there was no differentiation between general education students and students with disabilities. Therefore, the results may have been different if the study focused on a more specific student population (e.g. students receiving special education services). References to students from other stakeholders and student participants were grouped into one category.

As the numbers of participants for each category were limited in size, a larger sample of administrators, teachers, students, and/or parents could have given additional insight into the experiences of various stakeholders' use of a digital curriculum.

An additional limitation to the study was the data collection process. Data were collected following the cancellation of face-to-face instruction during the spring of the 2019-2020 school year due to the COVID-19 pandemic. This required interviews to be completed over the phone or through virtual conferencing.

A delimitation of the study is that it is narrow in scope. Experiences of one schools' stakeholders may vary greatly from another, whether they are of the same size, smaller, or greater. As such, generalizability of the results are the interpretation of the reader. Additionally, phone and virtual interviews added to the narrow scope of the study.

Summary

The use of Digital Curriculum Resources in education is quickly expanding. DCR has the potential to greatly benefit learners, but a lack of research exists surrounding the benefits and barriers impacting its use. This study aims to expand understanding of these benefits and barriers by exploring the experiences of stakeholders' use of a digital curriculum. Chapter II will discuss the background of this study through an analysis and review of existing literature and is divided into three sections: digital curriculum resources, barriers to digital technology integration, and how barriers are impacted by DCR. Chapter III presents the methods used in this study. Chapter IV describes the results of the study. Chapter V provides a discussion of the results and recommendations for further research.

CHAPTER II: Literature Review

Digital Curriculum Resources

The internet in 2020 offers a vast collection of online resources for teaching (Remillard, 2016). Most email inboxes are chock full of advertisements for various websites soliciting memberships to gain access to their curriculum. Curriculum, however, is a complex term. Numerous definitions exist to describe its meaning. Some might define this word as a list of topics that teachers are supposed to teach and students are supposed to learn. Other definitions can be more comprehensive than this content-centered concept (Mendez, 2019). Pepin et al. (2017) referred to the term curriculum as elastic, and stated it can range "from one-off worksheets to a full-blown curriculum scheme/programme" (p. 647). Oliva and Gordon (2012, as cited in Mendez 2019) described curriculum as a plan selected by the school that could be as small as a single unit of study or as broad as a program that covers specific content for multiple grade levels. This study aligns more with defining curriculum as programmatic by nature and encompassing at least one whole year of content.

Digital Curriculum Resources (DCR) have been available for more than two decades and the trend to move from printed textbooks to digital is not new (Usiskin, 2018). Countries across the world have been under increased pressures for schools to adopt and take up the use of digital materials (Devaney, 2013; Kampylis et al., 2013; Selywn, 2007; Usdan & Gottheimer, 2012). In late 2010, DCR made headlines in both the United Kingdom and the United States, as the Telegraph, a British newspaper, and the U.S. Education Secretary, Arne Duncan, made claims that textbooks were becoming obsolete due to the rising use of computers in the educational environment (Usiskin, 2018). In 2011, South Korea announced they were going to try and convert to digital textbooks for every school subject by 2015. They were met with significant challenges, however, specifically in the area of mathematics (Lew, 2016).

Advocates for DCR claim that these programs have the potential to transform the learning experience of students by offering content that is more relative and interactive (Choppin & Borys, 2017). Learners can center their learning on real-world challenges because digital content can constantly be updated and revised to fit a desired context. Students can move beyond the classroom by taking advantage of learning opportunities in various out-of-school settings, such as museums and libraries (Thomas, 2016). Remillard (2016) noted that DCR differs from a traditional paper-based text because it can assume a nonlinear structure. “Rather than offering a single path through a particular terrain, they often take the form of constellations with multiple possible connections and routes” (Remillard, 2016, p. 5). These multiple routes provide teachers with the opportunity to tailor instruction to the specific needs and strengths of an individual student or small group of students.

Khan Academy is one example of available DCR. By the end of 2018, the free site had more than 71 million registered users that could access the free resources available. More than 1.5 million of those people spend more than 120 minutes per month using Khan Academy over the course of that year (Khan Academy 2018 Annual Report, 2019). In their case study that investigated the use of Khan Academy in a 7th grade math classroom, Marple et al. (2019) found that the product was popular with both teachers and students, especially in the higher-performing classes. They reported a discrepancy, however, between the work on the screen and the work the students were doing in their notebooks. The authors expressed concerns that the product may not prompt students to reflect upon their own thinking. They also acknowledged that more research was needed that examined how struggling students engage with the curriculum materials.

Products such as Khan Academy are commonly used as supplementary microcontent to support the curriculum being used by teachers. Fitzgerald and Tisdell (2019) found that when used in this capacity, microcontent has the ability to benefit the student learning experience. They reported that the use of this digital microcontent "positively impacts student confidence, course interest and self-concept, and fostered a self-perception of improved learning ability and academic performance" (p. 21). However, more research is needed that explores whether these benefits still exist when DCR is used as the primary means for learning.

Barriers for Technology Integration

The introduction of any digital technology within the classroom has the potential to create barriers for learning. Ertmer (1999) categorized two types of challenges related to digital technology integration: first-order barriers and second-order barriers. Extrinsic challenges, such as the availability of digital technology and technology support, are first-order barriers. These barriers are extrinsic to teachers as they are outside of their control (Chen et al., 2012). Commonly, first-order barriers are described in terms of the types of resources that are either missing or inadequately provided in teachers' implementation environments. Equipment, time, training, and support are examples of such (Ertmer, 1999). Ertmer et al. (2012) identified that although many of these first-order, external barriers have been reduced within schools, they will likely never be eliminated altogether.

Intrinsic barriers, such as a teacher's self-efficacy using technology, exist with technology integration as well. Ertmer (1999) described these second-order barriers as "barriers that interfere with or impede fundamental change" (p. 51). Although schools can acquire technology and the necessary external support to support its use, educators need to believe that the technology will improve the teaching and learning process (Ertmer, 2005). It also requires that the learners understand the technology and how to use it to their benefit. As these barriers exist within the individuals using the technology, they are often more difficult to address.

First-Order Barriers

Previous studies have identified barriers related to the integration of technology in today's classrooms (Makki et al., 2018; Purcell et al., 2013). Factors such as cost, availability, time, and support continue to play key roles in the effectiveness of technology as a learning tool. Increasing infrastructure and acquiring technological tools is expensive, especially for rural districts and districts with a high percentage of at-risk students. As schools begin to consider the use of DCR as the primary curriculum, there is a high possibility that these factors will increase.

The availability of technology in any educational environment comes at a significant cost. Makki et al. (2018) identified that current integration barriers are more pronounced in low-income populations, where resources may be difficult to acquire. Should digital curriculums prove to be a more effective instructional tool, learners in low-income populations and communities may be at a disadvantage. All school communities must consider that there may be families within their district who are unable to obtain access to technology outside of the school environment.

Advances in technology have provided multiple options for acquiring network access. Households can acquire network access through Wireless Fidelity networks (Wi-Fi) and cellular networks. Yet, both methods require a monthly expense that can be hard to fund for low-income households. DCR often requires network access for learners to access the necessary materials. If a portion of district households cannot afford to provide Wi-Fi or cellular access, some learners will be at a disadvantage for maximizing use of DCR.

According to the National Center for Education Statistics (2019), 93.9% of children ages 3 to 18 had network access at home through some sort of device in 2018. This was an increase from 91.6% of school-age children in 2016. In 2018, 87.9% had access through some type of computer, 6.0% has access through a smart phone, and 6.1% of children did not have internet access (U.S. Department of Education). Although those statistics may continue to increase, it will still be a long time, if ever, until all students are able to access technology and the internet outside of the school environment. It is also important to note that smartphones are not necessarily capable of effectively loading and running the various resources embedded within a digital curriculum.

Second-Order Barriers

The impact digital technology can have on the growth and achievement of students relies heavy on the teacher's ability to effectively integrate a specific technology into their instruction (Al-Bataineh et al.; Chen, 2008; Gorder, 2008; Inan, 2010; Lew, 2016). Although a school's administration may be responsible for the selection of the curricular program to be used in the classrooms, ultimately it is the teacher who designs daily instruction. Therefore, "the decision regarding whether and how to use technology for instruction rests on the shoulders of classroom teachers" (Ertmer, 2005, p. 27). Multiple factors affect educators' choices of when and how to use digital technology.

One key factor affecting digital technology integration is the teacher's attitudes towards the use of technology (Durff & Carter, 2019; Miranda & Russell, 2012). There is tremendous pressure on teachers to promote student achievement. Many schools use student growth as part of annual teacher evaluations or offer monetary incentives to teachers related to student achievement. Many teachers choose traditional methods over digital technology because they've already experienced student growth through these methods (Durff & Carter, 2019). In addition, the traditional methods are what teachers may be more comfortable with. Teachers who are familiar with digital technology, however, tend to use it more. This is because their use has led to higher confidence in their ability to effectively integrate the digital technology into their instruction (Miranda & Russell, 2012).

Digital technology integration goes beyond educator experience or confidence, and could be linked to the individuals' pedagogical beliefs (Deng et al., 2014; Inan & Lowther, 2010, Miranda & Russell, 2012). Tondeur et al. (2016) identified "teachers' pedagogical beliefs act as a filter through which new knowledge and experiences are screened for meaning and relevance" (p. 557). An educator's willingness to adopt new digital technology practices can be dependent on whether or not they believe those practices support effective teaching and learning. Teacher-centered educators may often view digital technology as non-essential to the learning process if it does not align to their pedagogical beliefs.

Teacher pedagogical beliefs were one of the primary challenges for South Korea when they transitioned from paper-based curriculum to digital between 2011 and 2015. Lew (2016) identified teachers heavily relied on the previous paper-based curriculum for in-class tasks and lesson sequencing. Therefore, the teachers did not see a *relative advantage* to replacing the paper textbook with a digital version (Rogers, 1995). Based upon his observations, Lew (2016) recommended the need for "a new kind of teacher training at both the pre-service and in-service levels" (p. 49).

Pedagogical barriers could be linked to the pre-service experiences of teachers. Prior research has found that when teachers used digital technology in their pre-service college courses, they were more likely to use similar technology with their students when they began teaching (Durff & Carter, 2019; Taylor, 2017). It could also be linked to the teachers' experiences across their lives. Markauskaite and Goodyear (2014) theorized an individual's personal experiences of learning and teaching create what is known as a *folk-pedagogy*. This system of beliefs can create interference with the adoption of sound instructional and learning practices even if the new ideas are systematic and evidence-based. This could occur during a teacher's pre-service training or even during their time in the classroom. In studying teacher decision-making through this lens, Markauskaite and Goodyear (2014) found the everyday experiences of the classroom could gradually develop a systemic way of thinking for teachers regarding instruction. This could provide context to why pedagogical barriers related to digital technology integration are more detrimental for some teachers.

Supportive interventions are one way to address these second-order pedagogical barriers By providing targeted support to increase an educator's ability to use digital technology, they may be more likely to integrate digital technology into their own instruction (Makki et al., 2018). Collaboration with other educators, modeling instructional practices with digital technology, and administrative support are just a few examples of the targeted interventions that have been identified as possible supports for educators overcome these barriers (Mouza, 2002).

The culture of the school and school district also has the potential to impact teachers' decision to integrate digital technology within the classroom (Durff & Carter, 2019, Ertmer & Ottenbreit-Leftwich, 2010). Generally, in-service teachers shift their beliefs and practices to match the culture of the school they work for (Zhao & Frank, 2003). This is especially true for novice teachers, as they are still in the process of developing their beliefs about teaching. It should also be noted that people, in general, desire to fit in with a group of people. They want to feel like they belong to something. This might be even more critical for teachers due to the cohesive culture that typically exists in schools (Ertmer & Ottenbreit-Leftwich, 2010). The more a digital technology deviates from the existing values, beliefs, and practices of the school's culture, the less likely it is for teachers to successfully adopt and implement it (Zhao & Frank, 2003).

Culture can also make a positive impact on digital technology integration. Ertmer et al. (2012) found the attitudes of surrounding teachers have the potential to be one of the most influential enablers for digital technology integration. When teachers trust in the support of their colleagues, they are more willing to take risks with their instructional approaches. Digital technology should also be introduced in ways that support teachers' current practices (Tondeur et al., 2016). By appealing to the practices they currently value, you increase the likelihood teachers will adopt and integrate digital technology into their instruction.

Teachers can also benefit from observing digital technology in practice. Schools that foster a culture of collaboration often promote teachers observing and learning from one another. These observations can be designed to provide teachers with opportunities to view effective digital technology use. When teachers are able to observe the positive impact digital technology adds to their students' learning and engagement, they are more motivated to try integrating this technology into their own teaching (Ertmer & Ottenbreit-Leftwich, 2010).

How Barriers Are Impacted By DCR

The decision to adopt a digital curriculum as the primary instructional program is commonly made by principals and administration. "The adoption…is compulsory for all subject teachers, and…may evoke feelings of anxiety and frustration among teachers because of a possible increase in workload" (Chiu, 2017, p. 526). Teachers serve as the facilitator for technology. They are responsible for guiding the work of students, promoting conversation and communication within the program, and in charge of assessing student activities and performance on the program, all of which can be unfamiliar in the digital format (Lew, 2016). The adoption process differs for non-daily digital resources, which can be used to supplement a curricular program because these are voluntary. Teachers can choose to use them on an individual basis (Chiu, 2017).

Digital curriculum resources are advertised as having "the potential for greater interactivity, greater individualization and customization, increased and varied social interactions, lower cost and greater accessibility, and assessments systems embedded that can make digital materials more adaptive and assessment data more actionable" (Choppin & Borris, 2017, p. 664). However, among the subjects taught in schools, mathematics has special qualities that cause easily-adopted practices, which might be beneficial for other subjects, to be inconsequential for learning mathematics, potentially even harmful (Usiskin, 2018).

Digital curriculum resources have the potential to create a different way of learning mathematics for students. Ruthen (2018) identified "new media do not simply replicate the functionality of the old with increasing efficiency," but it does possibly create a different form of interaction between the user and medium, for example the introduction of instantaneous feedback (p. 2). Usiskin (2018) examined how five aspects of mathematics, symbolization, representation, deduction, modeling, and algorithm, were impacted by DCR. He found mathematical modeling and representation were better supported by DCR, while deduction was better supported by printed text. There was not a clear advantage between DCR and print in regards to symbolization and algorithm. Usiskin (2018) suggests that the ideal approach to instruction may be both print and electronic, but a number of factors make this challenging.

Having multiple modes of presentation for learning would increase the cost of materials for schools and increase the complexity for teachers.

The introduction of any new practice requires time to learn, plan, design, and prepare materials to properly support student understanding and development. Lack of available time can be a crucial barrier regarding technology integration (Hsu, 2016; Pittman, Gaines, 2015). DCR can potentially increase and expand this barrier, especially if the DCR do not align with the current instructional practices in place. Camilleri's (2016) study of her district's use of supplemental DCR found time to be a critical barrier. Although the daily use of DCR was found to be highly beneficial for students, time proved to be a consistent barrier for implementation. Instructional staff felt they lacked adequate time to learn the program and collaborate on its use. Camilleri (2016) also reported that the use of the digital curriculum varied from class to class as some teachers identified they simply did not have enough time in the school day to fit the supplemental digital program in to the already packed school schedule. It is important to distinguish, however, that these barriers may have been created by the DCR being added on to the already existing curriculum. Additional research is needed that explores how the barrier of time is impacted if DCR replaces the existing curriculum

The increase in necessary support for educators to properly implement new digital curricula is a critical concern for school communities. Network infrastructure within an institution has a direct effect on the ability of technology to work smoothly (Camilleri, 2016). Schools must consider the costs and resources available for providing a digital infrastructure to support a digital curriculum used regularly throughout the school day. Also, as prior research has suggested (Gorder, 2008; Makki et al., 2018; Miranda & Russell, 2012), teachers play an integral role in the implementation of digital technology. Therefore, substantial professional development may be necessary both prior to and during implementation of these curricular programs.

Summary

Digital curriculum resources have the potential to transform the learning process for students. Through DCR, teachers can create instruction that is engaging, interactive, and tailored to the unique needs of each individual student. Barriers exist, however, to successfully implementing DCR. Schools must be able to acquire and upkeep the required network infrastructure, devices, and ensure equal access for students to digital resources outside of the school environment. Additional time for training, support, and planning is required not just to introduce the program, but also to support its ongoing use and regularly keep stakeholders up-to-date with changes made to the program over time. In order for schools to optimize student achievement through the use of DCR, additional research is needed that further explores the benefits and barriers of technology integration and how they are impacted by DCR.

CHAPTER III: METHODS

This study attempts to contribute to our understanding of digital curriculum resources (DCR) by answering the following research question: How do one district's stakeholders describe the supports and barriers to usage of a digital mathematics curriculum?
The following subquestions were used to guide the methods: (a) How do one district's administrators describe the supports and barriers to usage of a digital mathematics curriculum? (b) How do one district's teachers describe the supports and barriers to usage of a digital mathematics curriculum? (c) How do one district's students describe the supports and barriers to usage of a digital mathematics curriculum? (d) How do one district's parents describe the supports and barriers to usage of a digital mathematics curriculum?

Chapter III describes the methods used to collect data related to the experiences of various stakeholder groups of one school district that uses a digital mathematics curriculum. Section one will describe the research design used as a foundation for this research. Section two details how the research site and participants were selected for this study. Section three describes the methods used for collecting the data from the research site and participants. Section four outlines the procedures used for analyzing the data collected. Section five defines the measures employed by the researcher to improve reliability and validity. Section six provides a summary of Chapter III.

Research Design

I selected a descriptive case study design to explore the experiences of various stakeholder groups' use of a digital mathematics curriculum. Yin (2018) defines case as "a contemporary phenomenon within its real life context, especially when the boundaries between a phenomenon and context are not clear and the researcher has little control over the phenomenon and context" (p. 13). The case study method allowed me to closely examine the data within a specific context (Zainal, 2007). As a result, I can produce detailed qualitative accounts that help to describe the data and explain the complexities of the real-life environment and situation in which I am immersed. These types of accounts are not always captured through survey and experimental research (Zainal, 2007).

For this study, I examined the stakeholders' experiences using a specific digital mathematics curriculum at a suburban middle school. As this research was focused on the nature of a single, specific program, it follows a holistic, single-case study. Yin (2018) suggests that this design is advantageous when the theory underlying the case is holistic in nature, yet there is the potential for the results to be overly abstract and lack clarity.

Setting

A critical step of case study research is to define the case to be studied (Yin, 2018). This included the setting in which the research will take place. Therefore, I used purposive sampling to intentionally select the school that I work at as the research site. This was because I knew that the school used a specific digital curriculum for teaching mathematics and I had prior experience with the program. The research site is a seventh and eighth grade suburban middle school in the Midwest that employs approximately 70 staff members and enrolls approximately 700 students. 48% of enrolled students are white, 45% of students are black, 5% are Hispanic, and 2% are of other ethnicities. 60% of students are classified as economically disadvantaged. Less than 20% of students are proficient in Math and English. Statistics were purposely left vague to protect anonymity of the school.

Participants

Participants included administrators, teachers, students, and parents of students from the school selected for the study. Yin (2018) recommends screening candidate cases to be used for the case study unless the researcher has a special arrangement or access to candidates. As I was employed as a mathematics teacher at the time of this study, I had unique access to participant candidates for the study.

At the time of this research, the school employed two administrators, a principal and assistant principal, and six mathematics teachers, three of which taught seventh grade and three that taught eight grade. As I was one of the six, that left five potential teacher candidates for the study. As a teacher of the school, I also knew that these two administrators and five teachers had approximately 18 months experience using the digital curriculum. Therefore, I used purposive sampling to select the two administrators and five teachers as cases for the study.

Yin (2018) does not recommend a particular number of participants for a case study, but Fusch and Ness (2015) identify that it is important for a researcher to try and reach *data saturation*. Fusch and Ness (2015) describe "data saturation is reached when there is enough information to replicate the study, when the ability to obtain additional new information is attained, and when further coding is no longer feasible" (p. 1408). Initially, I chose to select 10 students and 10 parents for this study to try and reach data saturation. However, following the first round of interviews with parent participants, I found that I needed to increase the number of parent participants. Therefore, 15 parent participants were chosen for this study.

In order to properly evaluate the digital curriculum, it was critical that I select student and parent participants from a class that consistently uses the digital program as the primary means of instruction. As use of the digital curriculum may vary from teacher to teacher, I selected student and parent participants from the classes of one specific math teacher at the research site. Prior to the collection of data, I completed classroom observations of the math teachers at the school. Based upon those observations, I used purposive sampling to select the teacher that had demonstrated competency and consistency with both technology and the digital curriculum used by the school for mathematics.

I selected students and parent participants from a population of 118 eighth grade students who currently used a digital curriculum for their eighth grade math or algebra course under the selected teacher at the research site. These participants were selected using random sampling. I typed the 118 student names into a computerized random name generator. During the selection of student participants, I used the computer program to randomly select a name. I then attempted to contact the parent and asked if their child would be willing to participate in the study. If the parent or student did not want to participate, I randomly selected another name. This process was repeated until 10 student participants were chosen.

Parent participants were selected using the same computerized random name generator. After the program selected a student's name at random, I attempted to contact the parent to ask if they would be willing to participate in the research study. If the parent did not want to participate, I would randomly select another student name to contact. This process was repeated until 15 parent participants were selected.

Student participants for this study included three students who were enrolled in algebra, the advanced mathematics course offered to eighth grade, and seven students who were enrolled in eighth grade general math. Parent participants for this study included three parents who have a child enrolled in the algebra course and 12 parents who have a child enrolled in eighth grade general math.

Data Collection

Yin (2018) recommends collecting data from the following sources: documentation, archival records, interviews, direct observations, participant observations, and physical artifacts. Multiple sources of data reduce the possibility of bias and ensure greater construct validity in the findings (Yin, 2018). For this case study, I chose to collect documentation and interview data. Archival records and physical artifacts were not available for collection and I did not complete direct observations or participants observations due to my role as a teacher at the research site. This is discussed further in the researcher's position later in this chapter.

First, I collected documentation by interviewing the principal of the school selected for this study to document the selection, adoption, and implementation of the digital curriculum. I used the principal interview to build a historical background that could provide context to the case study. Yin (2018) identifies both strengths and weaknesses to using documentation as part of a case study. Documentation does have the potential to reflect bias of document's author and particular information may be deliberately withheld. Yet, documentation is unobtrusive and not created through analysis of the case. It can also provide broad information covering a long span of time and include specific details related to the case.

This principal interview was specifically focused on the curriculum used for this study. I asked the principal to describe the selection process that led to this curriculum being chosen, along with the rationale behind the choice. I also asked the principal to describe the history of the math department and previous curriculums. This interview was recorded using the QuickTime application on a laptop. I transcribed the interview by typing it into a Microsoft Word document to make analysis easier.

Next, I collected data through participant interviews. Yin (2018) described interviews as "one of the most important sources of case study evidence" (p. 118). This is because interviews can be helpful with providing explanations of key events related to the case. There are typically three types of interviews in case study research: prolonged interviews, short interviews, and survey interviews. As I did not need interviews to occur over a prolonged period of time, I chose to use short interviews to collect data from participants. Based upon Yin's (2018) recommendations, I developed a case study protocol for each stakeholder group (administrators, teachers, students, parents) to keep interviews focused on the case study topic. The use of a interview protocol also increases the reliability of the results.

Protocols were designed to gather accounts of participants' experiences using a digital curriculum for learning mathematics. Moustakas (as cited in Creswell, 2012b) recommended the use of two broad, general questions to base the interview questions on: What experiences have you had surrounding the focus topic? What has influenced your experiences with the focus topic? These two questions focused attention on gathering data that would provide an understanding of the common experiences of the participants (Creswell, 2012b). Protocol questions were designed to be open-ended in order to allow participants to "best voice their experiences unconstrained by any perspective of the researcher or past research findings" (Creswell, 2012a, p. 218).

Each interview protocol contained six questions (Appendix A, B, C, D). Participants were asked what experience they have with a digital curriculum, what benefits they have experienced using a digital curriculum, what barriers they experienced using a digital curriculum, what needs they experienced while using the program, and what could be done to improve their experience using a digital curriculum. Follow-up questions were used as necessary to clarify responses. A final question was added to allow participants to share any information about their experience with the digital curriculum that the researcher did not ask about.

Although the topic of each question is consistent across protocols, I worded questions differently between stakeholder groups to improve clarity. Administrators commonly experience the program through observation. Therefore, I chose to alter the administrator questions to try and accommodate this perspective. I also chose to simplify several words within the parent and student questions to avoid complex terms that may not be easily understood. I also included the name of the program in the question protocols for parents and students to help focus their responses on the digital curriculum being studied.

I completed interviews individually with each participant. Creswell (2012b) identified one-on-one interviews allow the interviewer to ask sensitive questions and the interviewee to ask questions and provide input that goes beyond the questions on the survey instrument. Interviews also ensure a higher response rate. However, they do not allow for anonymity. As a result, some participants may not feel comfortable disclosing information during the interview.

Of the interviews, one administrator, four teachers, two students, and fifteen parents were interviewed over the phone using the Google Voice application. One administrator, one teacher, and eight students were interviewed using Zoom, a video conferencing application. I recorded all interviews using the QuickTime application on a laptop. Interviews ranged from 10 minutes to 30 minutes to complete.

I then transcribed interviews electronically by listening to the recordings and simultaneously typing participant responses into a Microsoft Word document. I chose this digital format to make data organization and analysis easier. Only the responses of the participants were considered in the data collection and analysis.

COVID-19

It is important to note that the methods of this study were impacted by the COVID-19 pandemic that occurred in the spring of 2020. Due to the pandemic, the school I selected for this study was closed in March of 2020 for the remainder of the school year. I intended for interviews with administrators, teachers, students, and a portion of the parents to occur face-to-face at the research location. Due to the closure, I was forced to alter data collection procedures to take place over the phone and through videoconference.

It is also important to note that the events of the COVID-19 pandemic might have added salience to the curriculum studied. At the time of the interviews, all participants were engaged in digital distance learning online. Administrators were spending the majority of their workday meeting virtually with various teams to coordinate distance learning, as well as plan for the remainder of the school year and the upcoming 2020-2021 school year. Teachers were responsible for hosting virtual office hours two days per week and posting a minimum of an hour of work for students to complete. Students were responsible for completing at least five hours of online work per week that was assigned by their five classes. Although the work was not mandatory for students, school staff was regularly working to communicate with families to encourage student participation. The pandemic greatly impacted parents as well, as home-life varied greatly from parent to parent. Some parents were working from home, trying to balance work and family life, while others were still going to work and coordinating child-care at home. Other parents had been laid off or lost their job. Therefore, it is difficult to know whether the COVID-19 pandemic and participants' experiences with distance learning positively or negatively impacted the responses during interviews.

Data Analysis

Yin (2018) identifies that "the best preparation for conducting case study analysis is to have a general analytic strategy" (p. 174). He recommends four general strategies for data analysis. The first strategy is to rely on the theoretical propositions that led to the development of the case study. With this approach, the researcher relies on the initial assumptions and previous literature to analyze the data collection. The second strategy is to work the data from the ground up and allow patterns to arise without preconceived assumptions. A third strategy is to develop a case description according to an already developed framework. Finally, the fourth strategy is to examine plausible rival explanations, an approach that can work simultaneously with the other three.

For this case study, I chose to follow Yin's (2018) approach of exploring the data from the ground up. I chose this approach in an effort to be open to the patterns that might exist within the data, but also because it has the greatest potential to identify additional relationships that may exist outside the bounds of the case.

My first step of analysis was an initial read-through of all participant responses to obtain a general sense of the data collected. Secondly, I read each transcript individually. During the analysis of each individual script, I highlighted important statements and assigned a code to each statement using in-vivo codes, or codes using the actual words of the participants (Creswell, 2012b). As described by Yin (2018), "each code [represents] a concept or abstraction of potential interest" (p. 169). After I completed the initial coding of all transcripts, I compiled a list of all codes into a Microsoft Excel spreadsheet.

My analysis during the second read-through yielded 197 unique codes. Using a spreadsheet for each stakeholder group, I grouped similar codes together and eliminated any redundant codes. By grouping similar codes, I reduced the number of codes down to 26 unique concepts. I created category headings for each concept by using the most descriptive words for each cluster. Returning to the data, I applied these 26 conceptual, categorical codes to the data to identify whether new codes emerged. During this analysis, I circled specific quotes from participants that supported the codes. In this third read-through, I confirmed the 26 categorical codes. Following confirmation, I completed a fourth read-through to fully immerse myself in the data.

As recommended by Yin (2018), I have provided an explanation of each concept in Chapter IV. Yin (2018) identifies explanation building as one analytic technique for case study research. The purpose of explanation building is to provide a description of how and why some outcome has occurred. Using these explanations, I identified a general theme for each stakeholder group (administrator, teacher, student, parent) to answer the research subquestions of this study. The analytic generalization of themes also ensures greater external validity in the results of the study. I then developed a qualitative narrative to support the identification of each group's theme. These are presented in Chapter IV.

Next, I organized the categorical codes for the four stakeholder groups (administrator, teacher, student, parent) into a single spreadsheet. I placed each stakeholder group in a separate column and listed the categorical codes associated with that group. Yin (2018) identifies pattern matching as one of the most desirable techniques in case study analysis. This process involves taking the patterns identified during analysis and relating them back to patterns of descriptive features that were defined by the researcher prior to beginning data collection (Yin, 2018). I chose to not follow this process; however, as I wanted to explore the data without preconceived assumptions. Therefore, I chose to explore the relationships between the concepts for each stakeholder group to identify whether commonalities or contradictions existed between the stakeholder groups.

I identified three themes during this comparative analysis. One theme was common between teachers and students. One theme was common among administrators, teachers, and students. I selected the third theme by attempting to answer the primary research question: How do one district's stakeholders describe the supports and barriers to usage of a digital mathematics curriculum? I constructed a qualitative narrative for each theme to support my analysis. These narratives are presented in Chapter IV.

Researcher's Position

One critical distinction between quantitative and qualitative research is the role that the researcher plays in the data collection and analysis process. With case study research, the researcher serves as the primary tool for data collection and analysis. Therefore, it is important that I acknowledge the impact personal biases, limitations, and views may have on my collection, analysis, and interpretation of data.

I approached this thesis case study as a middle school mathematics teacher, and as a graduate student in educational leadership. At the time of this study, I was working as a mathematics teacher at the suburban middle school used in this study. I was certified to teach kindergarten through 5th grade general education, 6th through 8th grade social studies and mathematics, and kindergarten through 12th grade special education. I was in my fifth year teaching and had approximately two years of experience using the digital curriculum.

The idea for this study came from my interest in learning more about digital curriculum resources. I spent the first two years of my career teaching middle school mathematics with a paper-based curriculum for an urban charter school. Although I loved the school, I did not enjoy working with the curriculum. The curriculum was designed to be teacher-centered and students regularly commented that it was boring, overly difficult, and rarely applicable to the outside work they lived in. As a result, I found myself constantly supplementing my instruction with various DCR to make my lesson more engaging and meaningful for the students.

I was hired by the middle school used in this study in June of 2017. At that time, I was assigned to teach social studies for the 2017-2018 school year. The curriculum discussed in this study was selected during the spring of 2018, therefore I did not participate in the selection process. I was contacted by administrators in the summer of 2018 and asked to explore Math Techbook, the new digital program selected for seventh and eight grade math classes. I found the program to be exciting because it provided solutions to many of the challenges I experienced using the curriculum at my previous school. It was student-centered, interactive, engaging, and different.

After sharing this feedback with administrators, I was informed that two teachers from the math department would not be returning for the upcoming year. , I was offered the option to change subjects and teach mathematics. I accepted the change and began teaching math with the program to start the 2018-2019 school year.

Summary

This descriptive, qualitative case study was designed to explore how various stakeholder groups of a suburban middle school describe their experiences using a digital curriculum for mathematics. I used purposive sampling to select the school that I work at because it currently uses a digital curriculum for learning mathematics. I collected data from building administrators to develop the historical background provided in this chapter to add context to the results presented in Chapter IV. I selected administrator and teacher participants using purposive sampling to ensure that participants had experience with using a digital curriculum for learning mathematics. I selected student and parent participants using random sampling from the classes of one teacher that demonstrated competency using the digital program. I interviewed participants over the phone and using videoconferencing using a protocol of questions that were designed to explore the experiences of each participant.

Interviews ranged from 10 to 30 minutes and were recorded and transcribed electronically for analysis. The data was coded and grouped into categories. Analysis yielded 26 categorical concepts. These concepts were used to identify an overall theme for each stakeholder group. A comparative analysis between stakeholder groups identified two additional themes that occurred among multiple participant groups. Finally, an overall theme was identified to describe the collective data from all stakeholder participants.

CHAPTER IV: RESULTS

The purpose of this qualitative case study was to better understand stakeholders' experiences with a digital curriculum for learning mathematics. This chapter presents the results of the study. First, a historical background is included to provide context to the results of the study. Information within this section was obtained through an interview with the school's administrator.

Next, a description is included for each of the 26 categories identified during the data analysis. Six categories were identified from administrator responses. Seven categories were classified from teacher responses. Student interview responses yielded eight categories. Three categories were established by parents' responses. Descriptions include direct quotes from participants to support categorization.

Following these descriptions, a narrative is included for each of the four stakeholder groups that attempts to address the following research subquestions: (a) How do one district's administrators describe the supports and barriers to usage of a digital mathematics curriculum? (b) How do one district's teachers describe the supports and barriers to usage of a digital mathematics curriculum? (c) How do one district's students describe the supports and barriers to usage of a digital mathematics curriculum? (d) How do one district's parents describe the supports and barriers to usage of a digital mathematics curriculum?

Additionally, two themes were identified that occurred across multiple stakeholder groups. A qualitative narrative is included for each theme as support. Finally, a third theme was selected that attempts to answer the primary research question: How do one district's stakeholders describe the supports and barriers to usage of a digital mathematics curriculum?

Historical Background

During the summer of 2017, the school district used in this study unveiled its new strategic plan for 2017 through 2022. One of the five primary strategic focus goals was to enhance teaching and learning through the use of technology. As part of this goal, the district set the following objectives: continue the purchase and replacement of infrastructure, hardware, and software, create a professional learning process for current and future staff needs, upgrade and increase network and infrastructure security, review and enhance infrastructure technology support within the district, and investigate and implement new technologies and applications as needs. Additionally, the district set the goal of transitioning the high school to a one-to-one digital device-to-student ratio by the 2018-2019 school year and the middle school by the 2019-2020 school year.

The curriculum discussed in this study was selected in 2018. The previous curriculum, a hybrid math program that incorporated a paper-based component along with a digital math lab, had been in place for five years. Administration reports, that over that five-year period, there was no significant improvement in the district's math scores on state standardized tests. In the spring of 2018, a joint committee was formed between district's intermediate school (5^{th} - 6^{th} grade), middle school (7^{th} - 8^{th} grade), and high school (9^{th} - 12^{th} grade) to select new math curricula for the three buildings. The committee included at least one administrators and one math teacher from each building.

The committee used a curriculum evaluation site called edreports.org to guide their search and selection. Initially, the committee selected 10 programs to consider. They acquired materials from the companies and invited the math teachers from each building to look over the materials and asked each teacher to select the three they liked the most. Using the teachers' input, the committee reduced the list of 10 down to four and scheduled presentations with the four programs for the math teachers of each building. Following those presentations, each participating school took a vote for the curriculum they wanted to select. The high school and intermediate school voted for a paper-based curriculum. The middle school voted four to three to select the digital curriculum, Math Techbook, used for this study.

Math Techbook, a product of Discovery Education, is advertised to “engage student and drive achievement with dynamic content” (Discovery Education, 2019). The program is designed to balance conceptual understanding, procedural fluency, and application of real world content. It also offers instructional features that provide teachers with real-time data to support differentiating and personalizing instruction for the specific needs of learners (Discovery Education, 2019).

EdReports.org, an independent nonprofit that evaluates educational curriculum, analyzed Math Techbook in 2017. At the time of their evaluation, Math Techbook was available for sixth, seventh, and eighth grades. Their analysis is broken into three categories: focus and coherence, rigor and mathematical practice, and usability. The category of focus and coherence, as well as rigor and mathematical practice, target the alignment of the program’s content with the standards for that subject area. The usability category focuses on the design of the instructional materials and analyzes whether they are user-friendly for both the instructors and the learners (EdReports.org, 2017).

Math Techbook received a score of 14 out of 14 possible points, or *meets expectations*, in the area of focus and coherence. The program received a score of 18 out of 18 possible points, or *meets expectations*, in the area of rigor and mathematical practice. In the area of usability, the program received a score of 29 out of 38 possible points, or *partially meets expectations.* In their analysis of the usability, the programs assessment materials were scored as a six out of a possible 10 points and the programs ability to differentiate was scored as an eight out of a possible 12 points (EdReports.org, 2017).

At the start of the 2018 – 2019 school year, the middle school acquired new carts of 36 Chromebooks for each of the six math classrooms. The Chromebooks would remain in the classroom and be used primarily for the newly acquired math curriculum. Teachers were responsible for keeping track of the Chromebooks, making sure they were accounted for at the end of class, and plugged in to charge at the end of each day.

At the start of the 2019 – 2020 school year, the district purchased Chromebooks for every student enrolled at the middle school. Students checked out the device at the start of the school year and were responsible for transporting these devices to and from school, charging them, and carrying them from class to class throughout the school day. The carts from the previous year were transitioned to the intermediate school. The district also re-assigned a staff member from the district’s information technology department to be stationed at the middle school full-time to provide technology support for both staff and students.

Discovery Education provided training to teachers and administrators during both the 2018 – 2019 and 2019 – 2020 school years. Staff participated in a six-hour training session prior to the start of both school years using the program. Training was designed to explore the program and learn more about its use in the classroom. Teachers also participated in three half-day trainings with Discovery during the first school year and a half-day training during the second year.

Administrator Concepts

Addresses Perceived Needs of Learners

Administrators expressed that Math Techbook addresses the current needs of their students. Administrator A stated, "The level of questions [within the program], the application questions, are where we need to get kids." They also indicated that the monitoring tools within the program, the focus and coherence, the rigor, and the alignment with the curriculum standards being used were strengths of the program over other competitors. Administrator B voiced that the concept-based approach of the program benefits the students more than a procedural approach. "They are applying real-world concept things and understanding the logic behind what they're doing." Administrator B also mentioned that the program is "geared towards different learning styles."

Program Isn't Perfect

Administrators acknowledged that the program is not perfect, but also pointed out that no program is. Administrator A identified the usability of the program as an issue. They discussed how Edreports.org rated the program's usability as 29 out of 38 for all three grades, stating "I think I'd agree with that." According to the websites rating system, a score of 29 means that it partially meets expectations. Administrator A also expressed that the assessment portion of the program was an issue. Administrator B felt the program had barriers for low-performing students. "There are barriers because some of our students are behind. I think that the program doesn't necessarily take into account all of the misconceptions and prior knowledge students do or do not have around the concept."

Training for all Stakeholders

Administrators acknowledged that training was a significant need for improving use of the program. Administrator B voiced that "kids need to be trained better. I think the staff needs to be trained a little bit better. Parents, I think we need to do a little bit better with training parents," stated one administrator. They pointed out that the program differs a lot from what math looked like for the parents of students. Administrators expressed concerns about this, stating "if we get parent participation at home, it's going to even be less because they're less familiar with [the program], so parent training is needed."

Pedagogical Barriers

Administrators identified math as "a distinct area of struggle" and that the school has "fundamental issues in math." Administrator A noted that teachers need support with learning how to workshop with students, an instructional approach that is currently used by the English department that has had great success. Administrator A also expressed a need for teachers to implement more blended learning in the classroom. Administrator A commented that they want teachers to "[let] kids take more control of their learning. We are still teaching from a power standpoint where we…impart knowledge onto the students instead of letting them discover some things for themselves." Administrator B felt these pedagogical barriers were holding the program back. "It would be better if teachers used the program the way that it was designed to be used. More so than trying to supplement with the pieces they are comfortable with."

Administrators voiced that the pedagogical barriers may be the result of a non-growth mindset in teachers. Administrator A described how teachers are "holding onto the old ways of teaching where we put everybody in rows, I model on the board. I do, we do, you do, which is not terrible, but it can't be the only way we instruct." They noted that this method didn't produce the desired results in previous years and continues to not be productive today.

Non-growth Mindset in Students

Administrators also discussed the prevalence of a non-growth mindset in students, stating that there has been a lack of student accountability in regards to their learning. "The productive struggle is hard to get them through if they're not used to doing it and they don't understand the concept of 'yet'," voiced Administrator A. They identified deficits in perseverance and tenacity for students. "If I can't get it the first time then I give up on it." Administrator A felt that teachers and coaches modeling the growth mindset would help improve the mindsets of students.

Teachers Need Coaching and Collaboration

Administrators suggested coaching and collaboration as options for helping address the program deficits, training needs, pedagogical barriers, and mindsets of students and teachers. Administrator A voiced that they felt administration would not be able to illicit change in the classroom. They acknowledged that the school used to have a mathematics coach, but the previous superintendent abused that position. As a result, it broke the trust between the math teachers working at the school and the coach. Administrator A suggested this is why some teachers are hesitant to change. "[Coaching] became a compliance piece, where administrators would have to walk in with checklists and if you weren't doing this or weren't doing that."

Administrator A voiced that feedback needs to come from someone not in a position of power. "[Administration] can't change it. Even as supportive as we want to try and be." They commented, "if we had the right person…where we could go with that and just get through the whole PTSD of 'try-it' and it will be okay. We can't do worse than where we're currently at." Administrators explained that these coaches could support learning how to workshop with students by pushing into the classroom and working with groups of students. They also suggested that this coaching position could support the collection and analysis of student data to drive instructional goals. “Teachers don’t have time to pull all the data. To have somebody else that could…and say, here’s what [the data] says, on this concept, what are we going to do about it? Here are some ideas. Let’s try them.”

Administrator B identified facilitating teacher collaboration with other academic institutions using the curriculum as another possible solution for addressing the pedagogical barriers. “I wish we were in touch with more schools that use [the program], to see how they use it, what works, what doesn’t…You’re going to learn better from teachers than from a coach or principal coming in.” Administrator B disclosed that the middle school is the only school in the district and surrounding areas that currently use the program, so they would like to connect with schools in other regions that use it.

Teacher Concepts

Program Benefits

Teachers identified numerous benefits with the program. They liked the interactive activities within the program, the accessibility of the program for users, the ability for the text to be read aloud, instantaneous feedback for users, and the variety of resources embedded into the program. Several teachers voiced, however, that they felt the program benefited the higher-level learners far more than lower-level learners. One teacher commented:

> Higher-level learners can go ahead with things on their own and jump ahead because they have the skills, but I don’t really see any benefit for our lower level….The lower end needs more direct instruction and help. I think that’s because of their skills. Typically

> when they're lower in one subject, they're lower in others, so they have difficulty reading and understanding many of the things.

Another teacher described how he's seen high-functioning students grow a tremendous amount by using the program "to enrich their understanding, to further their understanding and go into topics that we wouldn't necessarily cover in class."

There are Other Ways to Learn

Teachers also discussed pedagogical barriers with the program. Three teachers voiced that students don't need to use a chromebook every day. "There are other ways to learn. We don't have to use the Chromebooks every day." One teacher identified that teachers and administration may have conflicting views about the use of the devices. "Administration does need to realize that we don't need them every day because I think they have it in their mind that if they have their own Chromebooks, they need to use them every day." However, administrators did not voice that they expected Chromebooks to be used on a daily basis.

Three teachers expressed that low-achieving students require more direct instruction and guidance to learn. They voiced that this was not supported by the discovery-based format of the digital curriculum being used. These teachers felt that there should be a balance between the paper-based and digital materials. "Digital technology can be a great thing in math, but if it's not broke, don't fix it. The program needs to constantly be supplemented with good old arithmetic."

Training for all Stakeholders

All teachers acknowledged a need for training, yet it was apparent that the needs for each teacher varied. One teacher noted that they just wanted more practice with the program, saying "there's just so much information, so many options, that you forget about certain things". Another teacher voiced that they wanted training focused on implementation. "We do get professional development ON the curriculum and HOW the program might work, but not necessarily on the implementation in a classroom setting.” Teachers felt that knowing how to use the program was critical to students’ success with it. “You have to be quite skilled at utilizing the curriculum tools and then teaching the students how to use those tools to their benefit.”

Three teachers expressed they felt frustrated by the program being updated multiple times throughout the year with no virtual or in-person training provided to support the updates. “The frustrating thing is that I get used to one format of the curriculum tool and then they change it…because it’s simpler. Simpler for who?” One teacher urged program designers to consider the veteran teachers who are not technologically savvy when making changes. “If they’re not familiar with how things work, just technology wise, and they change stuff on them. I’ve watched somebody’s facial expressions go from excited to I-give-up in a matter of 10 minutes.” That teacher voiced that program designers must not only think about how to improve the program over time, but also how to continually provide support for the users of the program.

All teachers requested more training with the program, not just for staff, but for students and parents as well. “I think training kids with the digital tools is critical because…if they don’t know how to utilize that tool, it’s useless.” Teachers voiced that even general training on how to use their devices would benefit their learning. “I think a lot of the time we assume they know what to do when some of them really don’t and then they’re afraid to even ask because of those kids that already do.”

Teachers discussed how parent training would help benefit the support available to students at home and parents’ connection with the school. “I don’t think the program is as parent friendly as it could be. Parents have a hard time understanding if kids need help with anything…they want to [help], but they don’t know how to, so they’re kind of stuck.” Teachers felt that there was a lack of parent resources available within the program and voiced that engaging parents through training might help them better understand the goals of the program and the resources available through the program to students.

Curriculum Needs

Teachers identified numerous changes they would like to see with the program. They mentioned wanting more practice built into the program, more resources and activities for the students, more printable options for the curriculum, and more flexibility for the teacher to adapt the lessons. "There are parts of it that are cumbersome. I think it needs to be streamlined a little better for [students] to be able to manipulate all the way through it." One teacher voiced that they would like the program to support more interaction between students and teachers. Currently teachers can view student work that is submitted, but "we need to be able to, on different devices, if the kid is doing a problem in real-time, we need to be able to help them correct it." Teachers also expressed that they felt this digital curriculum did not support student interaction as much as previous math programs used at the school.

Similar to administrators, teachers described issues with the assessment portion of the program. They voiced not being able to edit the assessment materials available within the program. "Their testing component is horrible. That's a major disaster when you can't go in and change problems." Pre-made tests are available for each unit both digitally and in print format, but they cannot be altered. In order for teachers to create their own assessment, they must choose questions from an available testing bank that has limited options for some content. They also complained about the program's ability to assign digital assessments. They wanted some type of "lock-down menu…where kids can't go anywhere else." Currently, the program allows teachers to assign an assessment to a student, but that assessment is accessible by students until the end of the calendar day and they have the ability to access other computer content while the assessment is open.

Computer as a Distraction

All teachers expressed that the digital devices used to access the curriculum also serve as distractions to the learning environment and are a serious problem throughout their classes. “I think kids need to learn computer etiquette, or how to use the Chromebook properly, so that you only have your math tab open, or you’re only supposed to be on this, not on some YouTube video.” Teachers identified that it is too easy for students to stray to other websites when they are not supposed to be there. One teacher felt this was caused by a lack of motivation and self-discipline. “If a student’s not disciplined to actually do what they’re supposed to do, they get sucked into the vortex of the internet. That’s the biggest challenge I see, especially with those students that struggle.” Another teacher voiced that their primary barrier during instruction was “the computers and not being able to keep them on task. Not being able to regulate exactly what they’re doing on the digital piece.”

Teachers indicated that games were one of the most common distractions during class. “They come in and just start playing video games the moment they get into class,” commented one teacher. Another teacher indicated that games were addictive for the kids. “They’re so invested in those crazy games that the temptation is absurd. As soon as they block them, they’ve found a new one.” The school does utilize various network securities to block websites, but students often use proxy servers to work around the firewalls that block out the games. One teacher voiced significant frustration regarding this:

> There was a whole bunch of these proxy servers, like myteachersstupid.com, where that particular browser or website would circumvent your system by utilizing the website to

help you go to a game or whatever. And I'm like 'how many of those are there?' And the student said "a lot of them." And I said, you know what, I'm done.

Cheating

On top of the devices creating distractions within the learning environment, three teachers also indicated that they have led to an increase in cheating by students as they have located various resources that allow them to cheat on their assignments and assessments. "The kids can just look up answers and they spend more time trying to figure out how to look up answers than to do the problem…I have to police the room, so I can see exactly what they're doing." Teachers voiced that a lock-down mechanism would allow them to monitor student's progress and help remove the temptation of cheating and visiting other websites.

Loss of Instructional Time

Four teachers identified that the regular use of technology has led to lost instructional time. Some of this time is lost to answer entry, especially for the higher-level math classes like Algebra. "When you have problems that have seven or eight steps, I could spend 15 minutes having them put everything in for one problem." That same teacher voiced that it takes significantly less time to have students write it down, but then they would be unable to utilize the virtual dashboard that allows them to project student work quickly for class discussion and analysis. Teachers also discussed the training requirements related to computer use and program use as a cause for lost instruction time. They expressed frustration by the amount of instructional time that had to be used to train students with the program and commented that their frustration was compounded when the program would be updated throughout the school year.

Student Concepts

Variety of Options

70% of students voiced that they appreciated the variety of options offered by the program. “It always seems like there was never not enough information about a topic,” voiced one student. Students appreciated that the program presents information in multiple ways and that there are lots of videos on the site to help their learning. “On the chrome book, I feel like I have so much MORE at my fingertips.” They also discussed the variety of tools and interactive glossary that are embedded into the program. “I like how it has…like all the different tools on the side. The tools are really helpful, and the glossary, I really like that.”

Digital Accessibility

60% of students appreciated the accessibility of the program. One student commented, “I liked how accessible it was because I knew if I got home and I still had a question on something, I could go on my phone even and get whatever lesson I needed.” Some students felt the computer was easier to use that something paper-based because they spend a lot of time using computers, so it is easier for them to finish their work.

Immediate Feedback

A common benefit expressed by all student participants was the immediate feedback they receive from the program. One student described why they felt this was beneficial:

> It gives you feedback on your answers, like if you do it wrong, it’ll give you a reason why you got it wrong and if you get it right, it will tell you, which is helpful because I don’t want to keep trying something over and over if I’m ready to move on.

More than 50% of students identified that they felt the immediate feedback helped them assess what they did and did not understand.

Confusing Content

A common complaint among all student participants was the lack of clarity regarding directions, questions, and general information within the program. Students voiced that directions in the program were unclear or confusing at times. Students also felt the program did not always clearly explain what they were supposed to be doing within an activity or assignment. They indicated that clarifying directions and content was the main area they needed help from a teacher with. “I need clarification a lot of times on what it’s trying to teach because I don’t really understand what it’s trying to say.” Another student indicated that the questions caused confusion for them, stating “sometimes the questions are difficult for me to process. Like if they’re just worded with a ton of words, then I can’t actually identify what the actual question is.”

One student expressed that this issue greatly affects students who are absent and don’t want to fall behind. “Since it’s digital and sometimes there’s not always a teacher there saying what’s there, you can’t really understand what you’re supposed to be doing because the curriculum itself on the computer doesn’t really say exactly.” Another student voiced something similar. “Some of the investigations are confusing. When my teacher explains it, it’s easier, but I don’t feel like I could figure out the directions to some things on my own.”

Student Training Needs

Although students acknowledged the variety of options and resources available within the program, they also voiced that they had challenges locating those options and resources. Six students described issues with navigating the program and not knowing where to find things within the program. This is an area that could potentially be addressed through student training. One student voiced that they greatly benefit from the interactive tools that are available in the program, but also mentioned they are difficult to use at times as there are no directions explaining what to do. Another student identified that they know the program has additional resources, but they have a difficult time finding them. “It was a struggle to find stuff. Like I always knew it was there, but it wasn’t easy to get to it because I didn’t remember what lesson we were doing in class or maybe I was late to class.” One student suggested regular training throughout the school year, adding that “navigating the website was hard because you kind of got it taught to you once in the beginning of the year, and you should know it, but if you don’t, it was hard to ask.”

Internet Issues

40% of students mentioned internet issues as a barrier to their experience with the digital curriculum. “When we’re all using the internet, it kind of like slows down, and then you may not be able to like get it done in the timeframe.” Students said this was especially true when using the video content available in the program, as video streaming uses more bandwidth.

Answer Entry and Grading Confusion

60% of students discussed issues with grading and entering answers into the program. One student explained they “don’t like how if…you accidentally put an extra space, it will mark it as wrong.” Students ran into similar issues entering fractions, decimals, and negative numbers. By entering an extra character, the answer would be flagged as wrong by the program and the teacher does not have the ability to alter that mark within the program. Several students also felt frustrated by the program’s inconsistent grading. “It just doesn’t really make sense…the way they grade things…if you get it partially wrong it will grade it as all wrong, while sometimes if you get it partially right, it will grade it as partially wrong.”

Computer as a Distraction

Students also identified computers as a distraction during class. One student described how their computer is a distraction, stating "it was a struggle just trying to pay attention with learning online and stuff because I like having the ability to write it out." Another student voiced that the distractions come from their classmates. "I think it's harder with the computer because we have problems…with people going on different websites and stuff and there's no way to limit that when you're on a computer."

Paper-Based Preferences

20% of students voiced they would prefer to use a paper-based curriculum over the digital format. Both students expressed that they preferred to write things down because it helped them understand it and remember it better. When asked to clarify, one student commented that while writing things down is still an option in class, it was difficult to both write and type their answers into the program. The other student explained that it was difficult to fit the computer and notebook on their desk during class.

Changes to the Curriculum

Students recommended multiple changes to improve their experience with the program, including making the program more navigable and fixing the grading issues. One student suggested, "having a hybrid textbook and…computer, so there was a textbook to go with for students that liked writing [it] down." Two students wanted to see the program expand their interactive glossary to include more words within the program. One student pointed out that they did not use the program before seventh grade, so some important words in lessons that would have been clickable for the glossary of an earlier grade were not included in the seventh or eight grade version.

80% of students wanted to see the program improve the wording of directions and questions. “Some of the games…are confusing, but when my teacher explains it, it’s easier. I don’t feel like I could always figure out the directions…on my own.” One participant commented that they would like teachers to be able to make changes with the program. “I would change how they word things in the program because…some things that are there, the people created and not your teacher. And like, your teacher understands the students more.”

Parent Concepts

Program Experience

Only 13% of parents acknowledged having experience with the program. Multiple parents expressed that they’ve glanced at the program, but felt they did not have enough experience to be able to identify the benefits of it or the barriers to using it. Four parents without experience expressed that this was due to their child being independent and commonly not needing help with math.

Learning Styles Don’t Match

Four parents with no experience using the program did, however, shared their thoughts regarding the use of computers for learning math. All four expressed that they had difficulty understanding how math could be taught on a computer. “At a certain point you need to be able to know how to do the math by hand,” expressed one parent. Another parent commented, “when I saw that all the math was online, I thought it was weird because I’m old school. You should have a math book or you should have a piece of paper in front of you.” One parent attributed their lack of experience with the program to the fact that they’re unable to help their child with math:

> He hasn't come across anything where he's needed my help, probably because he knows if he does, we collide. Because the way I learned math and the way he learns math, totally different, and I usually just end up confusing him because it's so different. We come up with the same answer, you know obviously, but it's a whole different way to get to those numbers and I think their way is harder and they think my way is harder, so I try to stay away from the math.

One parent discussed how math was more difficult for some on a digital platform. "I love math and I thought that it was more difficult online if you don't know how to do it. I felt like kids that got frustrated with math, got frustrated even more and gave up." They also indicated that the teacher plays an important role in whether a student is successful. "You have to factor in what teacher you have and if the teacher is willing to help more."

Digital Benefits

The two parents who had experience using the program expressed that they felt the digital format was beneficial for mathematics. One of these parents voiced a preference for paper and pencil math, but felt the digital platform helped with visualizing the concepts. "I'm a visual person, so if I can see the steps, I find that beneficial versus just reading about…I wouldn't understand something as well as if I can see it drawn out." The other parent shared that they had previous experience with online math courses while at college. "I like that I'm actually able to understand the program. When he had questions, I was able to actually follow along and help him when he did need the help." Both parents also commented that they felt the program was easy to navigate.

Stakeholder Themes

Four themes, one for each stakeholder group, were identified as an attempt to answer the study's research subquestions: How do one district's administrators describe the supports and barriers to usage of a digital mathematics curriculum? How do one district's teachers describe the supports and barriers to usage of a digital mathematics curriculum? How do one district's students describe the supports and barriers to usage of a digital mathematics curriculum? How do one district's parents describe the supports and barriers to usage of a digital mathematics curriculum?

Administrators: Significant Instructional Needs

Administrators' responses indicate that significant instructional needs exist for the staff and students. Although both administrators discussed issues with the curriculum being used, they focused more on the needs of teachers and students. They expressed wanting to see a shift in the use of the program from a focus on teacher-centered instruction to student-centered instruction. "Some people are just dug into: this is way it's done and this is the way it will always be done. The problem with that is, it hasn't worked." They also identified a lack of student accountability and student perseverance with learning mathematics. Coaching, additional training, and collaboration with other schools were suggestions made by the administrators for achieving these changes and improving the experience of both teachers and students.

Teachers: The Program Doesn't Fit

A central theme of teacher responses was that the program does not fit the current needs of the learning community. "I think we are down-sliding with this program though because our previous program did a better job of getting the kids thinking and talking and going through the material." All teachers expressed that the program comes with numerous benefits, yet four of the five teachers expressed that the program's barriers overshadowed those benefits. All five teachers voiced concerns over the distractions created by the presence of computers. They indicated that students struggled to avoid straying to other websites during class to play games or watch videos. Four teachers conveyed that the significant need for training students with the technology resulted in lost instructional time for curricular content. Teachers also commented that numerous problems with the programs features led to increased frustration and stress.

Students: Indifferent to the program

Overall, students seemed to be indifferent to the program. As one student stated, "it's just like any other program." Students indicated a balance of both positives and negatives to the program and their experience using it. They liked the variety of options within the program, the immediate feedback, the accessibility, and the wide array of resources that are provided by the program. Students complained, however, that the content was confusing at times and difficult to use. They did not like the issues with entering answers or the difficulties with finding certain resources. They also identified that the use of digital devices can lead to additional distractions during learning.

Parents: No Connection

Parent responses reflected a lack of connection to the digital curriculum. 13 of the 15 parent participants reported have no experience with the program for various reasons. Multiple parents, however, attributed this to the differences between the math classes they remember from school and the math classes their children attend.

Major Themes

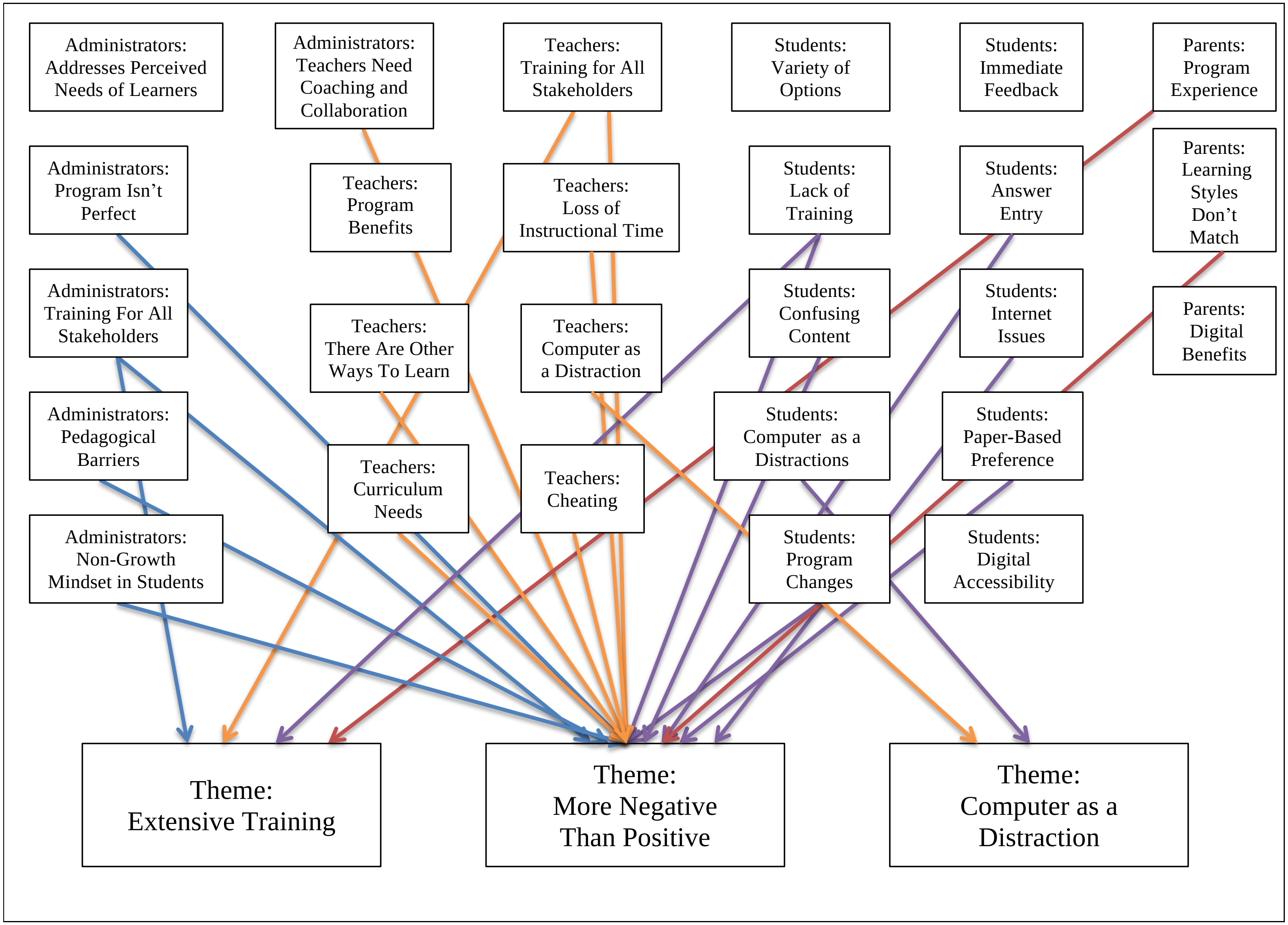
The researcher identified three main themes during data analysis. Two themes, Computer as a Distraction and Extensive Training, were identified during a comparative analysis between the category headings for each stakeholder group. Both teachers and students identified the computer as a significant distraction to the learning process. Administrators, teachers, and students identified the need for extensive training of all stakeholder groups. Parents' responses support this as only two of the 15 parents reported experience with the program. The third theme, More Negatives than Positives, is provided as an attempt to answer the primary research question of this study: How do one district's stakeholders describe the supports and barriers to usage of a digital mathematics curriculum? *Figure 1* shows the 26 categorical concepts and how they were used to identify the primary themes discussed in this Chapter.

Computer as a Distraction

Teachers and students identified that the computer can be a barrier to learning, as both indicated that computers were commonly causing distractions within the classroom. Teachers identified that it was too easy for students to stray to other websites, play games, or even waste time playing with brightness of their screen. Students acknowledged that they felt regularly distracted by these behaviors, even when they're not the ones responsible. They reported that the distractions make it harder for them to pay attention to the program.

Teachers shared they felt the need to regularly be policing the room for video games, social media, and cheating. One teacher even expressed that it has become such an issue that they reduced how much they use the computers in class. Some shared that cheating has become a serious issue, as students continue to find websites that solve the math for you or allow you to share answers to questions with others. They attributed these behaviors to students' lack of self-discipline and computer etiquette, lobbying for student training to support proper use of the devices.

Figure 1: Visualization of Themes from Categorical Concepts



Extensive Training

All stakeholder groups indicated a need of training. Administrators, teachers, students, and parents all expressed some sort of disconnect from the program due to a lack of understanding of the features of the digital curriculum. Administrators and teachers acknowledged a need for training for not just the staff, but also for students and parents. Both indicated that there had not been enough training for staff with the program, and no formal training for students and parents outside of what the individual teachers had provided during instructional time.

Teachers voiced the desire to have more support and feedback from a program expert on their instruction. They also acknowledged that it’s important not to make assumptions that specific groups, such as the students or parents, know how to use the technology. Teachers reported that they commonly lost instructional time due to students struggling to use their devices, navigate the program, use the program’s embedded tools, and input information within the program. Teachers also conveyed that training in computer etiquette would make a big difference in reducing the distractions caused by students inappropriately using their devices.

Student participants acknowledged difficulties with the program as well, all of which could be addressed through training. They felt the program could word directions better and make navigation within the software more obvious. Students appreciated the abundance of available information and tools, but also reported that it was difficult for them to find those resources when they needed them. They also expressed feeling frustrated and confused by the answer-entry features of the program.

Of the 15 parent participants interviewed, only two reported having experience with the program, yet every administrator and teacher participant voiced the need for promoting parent engagement with the program. Multiple teachers felt the program was not parent-friendly and that there was a lack of resources for parents within the program. Several parents reported that they did not have a connection with the program, as the digital approach to learning did not match the format they remember from mathematics classes when they were in school. Some parents stated that they are unfamiliar with the program because they avoid helping their children with their math because it confuses them more when they help. One parent stated that they felt it was "more difficult to learn math on a computer." Another parent identified that, "at a certain point, you need to know how to do math by hand." By supporting parents' knowledge of the program, teachers expressed that it would make them feel more connected with the math classroom and allow them to understand the wide variety of tools available within the program to help support their child's learning.

Administrators and teachers suggested coaching as an alternative approach to training. They indicated that a full-time mathematics coach could provide on-going support to teachers, students, and families by spending time in classrooms across the school observing instruction, providing feedback to teachers and students, teaching in classrooms, and more. One administrator also acknowledged that due to the lack of available time, teachers don't always have the ability to fully analyze the data they are regularly collecting with the program. They expressed that an instructional coach would be able to assist teachers with this.

Administrators also suggested networking with other schools that use the program as a way to provided training and professional development. They expressed that collaboration with other schools would allow teachers to share common effective practices to supporting teacher, student, and family use of the program.

More Negative than Positive

While stakeholders identified numerous benefits from their experience with the program, they identified even more negatives. Administrative participants expressed that the program, from their perspective, effectively addresses the current needs of their students. The rigor and coherence of the program is ideal. It supports different learning styles through real-world applications and is concept-based rather than being on the procedures of math. Yet, they identified that the program does not effectively address student misconceptions, lacks in its ability to illicit prior knowledge from students, and has significant issues with the assessment portion of the program. They connected these deficits to the usability of the program, identifying that usability was one of the program's lowest rated areas according to edreports.org. Administrators also indicated that multiple barriers are affecting teachers' and students' use of the program. Although they suggested that training and coaching could address these barriers, these programs will take time and resources to develop and implement.

Teachers reported that the embedded activities of the program have been very engaging for students. They expressed that the immediate feedback students receive from the program has greatly benefited their learning. They also voiced praise for the variety of resources available to students through the program. Teachers were critical, however, of the program's navigation. They indicated that those activities and resources are not beneficial if users have difficulty locating them. Some teachers commented that low-achieving students needs more guidance and support with the program, especially with navigation and understanding directions. They identified a lack of adaptability with the program, expressing frustration that they did not have enough control over changing the content within the program to accommodate the diverse needs of their students. Teachers also wished they were able to build in more practice, edit and build questions for assessing students, and reduce the amount of text that students are required to read at times.

Teachers indicated that it was significant to note that the program has not been used since the closing of schools due to the COVID-19 pandemic. “I know we gave them Chromebooks, but now we’re finding out that a lot of them don’t even have internet or those with internet don’t have a strong enough network” voiced one teacher.

Students enjoyed the multiple ways that the program presents information. Students also appreciated the variety of options and tools that are available and feel like there is “more at their fingertips with digital” curriculum. Numerous students, however, also commented on the lack of program adaptability. Students reported that they wanted teachers to be able to make changes within the lessons. Multiple student participants expressed frustration about the directions and explanations provided in the program, stating that their teacher explained it better. Some students stated that these differing directions, however, led to confusion. Students expressed that although teacher support helps during class time, they would be missing out on this if absent or working at home. Students also reported frustration that the program doesn’t always explain what to do and that there are too many words with some activities

Summary

This research aimed to better understand stakeholders’ experiences with a digital curriculum for learning mathematics. Analysis of the data collected yielded the following results: Administrators conveyed that there are significant instructional needs for teachers and students regard their use of the digital curriculum. They recommended coaching and training to support these needs. Teachers expressed criticism for the program and suggested that the curriculum may not properly fit the current needs of their students. Students indicated mixed feeling with the digital curriculum. They identified multiple benefits and barriers that have impacted their experience using the program. Parents reflected a lack of connection to the program as only two of the 15 participants reported having experience with the program. Some parents suggested this was a result of differing learning styles.

Three major themes occurred across multiple stakeholder groups. Students and teachers both identified the computer as a significant distraction to the learning process due to the temptation to misuse the device. Administrator, teacher, and student participants identified a significant need for training for all stakeholder groups involved with using the program. Parents' lack of connection to the program supports the need for training. Lastly, all stakeholder groups discussed more negative aspects of their experience with the program than positive.

CHAPTER V: DISCUSSION AND RECOMMENDATIONS

Overview of the Study

This qualitative case study aimed to better understand the experiences of various stakeholder groups' usage of a digital curriculum for learning mathematics. Data were collected through one-on-one interviews. Two administrators, five teachers, 10 students, and 15 parents from a suburban middle school that uses a digital curriculum for its math courses were interviewed. Participants were asked open-ended questions regarding the perceived benefits and barriers surrounding their experience. The interviews were recorded and transcribed for analysis. Data analysis yielded a theme for each stakeholder group, two unexpected themes among multiple stakeholder groups, and one major theme among all participants. The themes are as follows:

- Administrators primarily focused on the instructional needs of the community that have the potential to improve use of a digital curriculum.
- Teachers focused more on the negative aspects of the curriculum and identified that the curriculum may not properly fit the current needs of the students.
- Students seemed to have mixed feeling regarding the program. Students identified numerous benefits and barriers impacting their experience with the program.
- Parents had a lack of connection to the program as only two of the 15 participants reported having experience with the program.
- The computer can serve as a significant distraction to the learning process for both students and teachers. Teachers voiced that it was too easy for students to stray to games and videos online, creating distractions for nearby students. Student participants

described being distracted by both their device and the devices of others who stray to other websites.

- There is high demand for training with the program to support usability for administrators, teachers, students, and parents. All groups identified a need for some form of training to support use of the program and familiarity with the variety of resources available.
- Participants identified far more negative aspects of their experience with the program than positives. Participants appreciated the variety of resources and tools available to users, the immediate feedback provided by the program, and the real-world application of content. Participants also acknowledged that the program's accessibility and the interactive content were beneficial. They identified numerous barriers, however, related to the program and their experience using it. Participants voiced there was inadequate support for lower-performing students and parents, issues with the assessment portion of the program, and lack of content clarity. Participants also identified the computer as a significant distraction to the learning process and a lack of training to support use of the program.

Relationship with Previous Research

The results of this study support claims made by DCR advocates that the digital format has the potential to transform the learning experience for students. Administrators, teachers, students, and parents all identified that the digital structure provided multiple benefits to students' learning experience. Users appreciated the variety of resources and tools available in the program, increased accessibility to resources, and the interactive activities embedded into the lessons. Participants' responses also provide support for Usiskin's (2018) analysis of the impact

DCR can have on learning mathematics. Teachers, students, and parents acknowledged that the digital platform benefits the visualization of mathematics content, including modeling and representation.

Stakeholders expressed they experienced setbacks with the program as well. Issues with content clarity, navigation, lack of adaptability, and assessment features may support conclusions made by Pepin et al. (2017) regarding the development of DCR. The authors identified that coherence of DCR suffers as a result of authorship being spread across a group of authors who likely do not directly communicate with others. This differs from paper-based curricula where teams of authors usually work together to develop the product.

This research may also support Usiskin's (2008) recommendation that a curriculum with a print and electronic element are ideal for learning mathematics. Multiple students suggested they would prefer a hybrid curriculum because they acknowledged benefits to both the electronic program and paper-based approach. Additionally, both teachers and parents expressed that they felt some parts of mathematics were better on paper. A balanced curriculum with both elements would accommodate these preferences, but as Usiskin (2008) indicates, a hybrid curriculum comes with higher costs for schools and increased complexity for teachers, as they have to design instruction around two different types of modalities.

Looking through the lens of Roger's (1995) *Diffusion of Innovation* theory, the results of this study support conclusions that relative advantage, compatibility, complexity, and triability of the digital curriculum affected its adoption. Teachers expressed that the program did not fit the needs of the community. Therefore, there was not a perceived relative advantage over the previous program. Pedagogical barriers identified by the administrative and teacher participants support the conclusion that the compatibility of the program negatively affected adoption.

Students' complaints that it was difficult to locate resources and understand the content within the program indicate that the program's complexity negatively impacted their adoption. Finally, the common suggestion of a need for training conveys that triability negatively impacted adoption of the program.

This research indicates that stakeholders' experiences using a digital curriculum for learning mathematics have been negatively impacted by both first and second-order barriers, as described by Ertmer (1999). First-order external barriers included network access to the curriculum both at school and home. Although every student had access to a digital device provided by the school, network connectivity negatively impacted participants' use. Students described network issues during instructional time, especially during tasks requiring video content. Teachers indicated issues with network access at home for students.

There is also evidence that second-order, internal barriers impacted stakeholders' experience. These included conflicting instructional and pedagogical beliefs of teachers and possibly students as well. The results also suggest that second-order barriers had a larger impact than first-order barriers. This supports Ertmer's (1999) claim that second-order barriers often cause more difficulty to technology adoption than first-order barriers. Administrators and teachers both acknowledged pedagogical barriers with the program. Some teachers were more critical of the program than others and their responses indicated the presence of a teacher-centered mindset regarding instruction. Teachers suggested that there are "other ways to learn" and "lower-achieving students need more direct instruction," statements that could indicate a misalignment between the pedagogical approaches of the program and those of the classroom teachers. These results also support conclusions made by Tondeur et al. (2016), who identified that teacher-centered educators do not view technology as critical to teaching and learning.

Administrators identified this teacher-centered instructional approach as a barrier to the school's adoption of the digital curriculum and wanted to see teachers make a shift in their classroom and allow the students to take more control of their learning. That pedagogical shift can be difficult, however, for some teachers to make. It also conflicts with recommendations made by Tondeur et al. (2016), who expressed that, "regardless of teachers' pedagogical approaches, technology should be introduced in ways that align with teachers' current approaches, thus appealing to their values and increasing the likelihood that teachers will integrate and use technology" (p.569). If teachers are to make the instructional changes asked by administrators, they will need support to do so.

The introduction of new technology can disrupt the established routines and norms of a classroom (Ertmer & Ottenbreit, 2010). This can cause significant stress for veteran teachers who have spent years developing their class into a well-oiled machine. One teacher participant acknowledged this stress. They described how learning this program felt like they were back in their first and second year of teaching because they had to relearn so many things.

The hesitancy to shift away from a teacher-centered approach may also be due to a fear of losing control over the classroom. Chen (2008) identified that teachers attach "great importance to being able to control classroom processes" because they believe that more student autonomy would lead to lower student performance (p.73). As teachers' evaluations are largely based upon student achievement, they may not want to shift away from processes they've already experienced success with.

Administrators discussed instructional practices but not pedagogical beliefs, specifically stating, "it's not because of the people we have, it's because of what we are doing." Yet, the actions of teachers may likely be the result of their beliefs regarding the technology. If teachers do not believe in the effectiveness of the program, it will be critical for administrators to address this barrier as teachers' beliefs about the importance of a technology to the learning process were identified as a significant factor to successful adoption of the technology (Ertmer & Ottenbreit, 2010; Kim & Kim, 2012; Miranda & Russell, 2012).

Administrators suggested coaching and collaboration to support teachers' use of the digital curriculum. This aligns with recommendations made by Kim and Kim (2012), who identify that promoting observation and reflection among teachers can positively benefit both school culture and teachers' pedagogical beliefs. Ertmer and Ottenbreit (2010) recommend that teachers be provided with opportunities to observe the successful practice of others and witness positive student responses.

Additionally, participants' responses may shed light on the role that the school's culture plays in adopting new technology. Ertmer and Ottenbreit (2010) indicated that schools with a culture that has "not adopted a definition of effective teaching that includes the notion of technology as an important tool for facilitating student learning" are likely to have difficulty with technology integration. This may hold true for some of the teacher participants that were more critical of the program.

Implications of the Findings

The purpose of this study was to better understand stakeholders' experience using a digital curriculum. The findings are intended to support educational communities that are considering the adoption of a digital curriculum and provide them with potential areas of need which should be considered prior to and during implementation. The results of this study reflect that the adoption of DCR may require schools to take a different approach than they would with a paper-based curriculum. Although DCR offers widely expanded options for learning, the need for training various stakeholders groups separates it from its paper-based counterparts. Schools planning to adopt a digital curriculum need to consider how they will engage and support the various stakeholder groups within their community both prior to adoption and during its use.

The identification of computers as a barrier to learning by both teachers and students is significant. As students' use of technology for social media and entertainment increases outside of the educational environment, it will become critical for schools to consider how they will protect the learning environment from these temptations. The school used in this study already spends a significant amount of resources policing network traffic and trying to block out nonessential content, yet teachers and students still describe significant disruptions to learning from non-educational computer activity.

Future Research

This research identified that technology can be both a benefit and distraction to the learning process. As previously stated, although the school used in this study had numerous mechanisms in place to limit nonessential web content, the temptation of the internet continued to be a significant disruption to learning. As schools expand the use of technology as part of the learning process, they will need to develop ways to address these disruptions and minimize the negative impact they have on learning. Future research should investigate possible approaches that schools can take to minimizing the distractions created by technology in the classroom.

While DCR offers new ways for students to learn mathematics, it can create new barriers for students' learning. Previous research regarding second-order barriers focused on teachers, commonly referring to these as *pedagogical* barriers. These pedagogical barriers, however, may be present in students as well. Multiple students voiced that they did not like the digital curriculum because they prefer paper-based learning, an approach that they are most familiar with from their previous years of school. Future research should explore the role of students when using a digital curriculum and the factors that promote or inhibit its successful adoption.

Participants also identified the need for student training. Stakeholders expressed that students need training related to general computer use, computer etiquette, and using the digital curriculum. A study that explores the impact that training can have on improving students' use of technology would be valuable. Additionally, this research may help educators better understand student barriers to learning with technology and how distractions created by technology can be reduced.

Future research should also explore the use of training and coaching with digital curriculum resources to address second-order barriers related to teachers. Although the teachers in this study received training with the digital curriculum, numerous barriers still remained. Schools considering the use of a digital curriculum would greatly benefit from knowing how to maximize their professional development resources to best support teachers' adoption and implementation of the DCR.

Finally, the research identified a lack of connection for parents with the program. Families play a critical role in supporting students learning outside of the classroom. By better understanding the tools available within DCR, families are more apt to support their child's learning as well as monitor their progress. Future research should explore the impact parent engagement and training can have on student achievement and students' experience using the program.

REFERENCES

Al-Bataineh, A., Anderson, S., Toledo, C., & Wellinski, S. (2008). A Study of technology integration in the classroom. *International Journal of Instructional Media*, *35*(4), 381–387. https://search-ebscohostcom.nmu.idm.oclc.org/login.aspx?direct=true&db=eue&AN=508037766&site=ehost-live

Camilleri, J. (2016). *Blended Learning and Educational Technology: Using An Online-Digital Curriculum To Support Student Learning* [National Louis University]. https://digitalcommons.nl.edu/cgi/viewcontent.cgi?article=1233&context=diss

Chen, C. (2008). Why Do Teachers Not Practice What They Believe regarding Technology Integration? *The Journal of Educational Research*, *102*(1), 65-75. http://www.jstor.org.nmu.idm.oclc.org/stable/27548264

Chen, W., Tan, A., & Lim, C. (2012). Extrinsic and intrinsic barriers in the use of ICT in teaching: A comparative case study in Singapore. https://repository.nie.edu.sg/handle/10497/15814

Choppin, J., Carson, C., Borys, Z., Cerosaletti, C., & Gillis, R. (2014). A typology for analyzing digital curricula in mathematics education. *International Journal of Education in Mathematics, Science, and Technology*, *2*(1), 11–25.

Choppin, J., & Borys, Z. (2017). Trends in the design, development, and use of digital curriculum materials. *ZDM*, 49(5), 663–674. https://doi.org/10.1007/s11858-017-0860-x

Chiu, T. K. F. (2017). Introducing electronic textbooks as daily-use technology in schools: A top-down adoption process. *British Journal of Educational Technology*, *48*(2), 524–537. https://doi.org/10.1111/bjet.12432

Corkin, D., Ekmekci, A., White, C., Fisher, A. (2016). Teachers' self-efficacy and knowledge for the integration of technology in mathematics instruction at urban schools. In Adolphson, K. V. and Olson, T. A. (Eds.). *Proceedings of the 43rd Annual Meeting of the Research Council on Mathematics Learning*. Orlando, FL. https://www.rcml-math.org/assets/Proceedings/rcml_proceedings--2016.pdf#page=107

Creswell, J.W. (2012a). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research (*4th ed.). Boston: Pearson.

Creswell, J. W. (2012b). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications. Thousand Oaks, California.

Csorny, L. (2013). Careers in the growing field of information technology services. *Bureau of Labor Statistics, 2*(9). https://www.bls.gov/opub/btn/volume-2/careers-in-growing-fieldof-information-technology-services.htm

Deng, F., Chai, C. S., Tsai, C. C., & Lee, M. H. (2014). The relationships among Chinese practicing teachers' epistemic beliefs, pedagogical beliefs and their beliefs about the use of ICT. *Journal of Educational Technology & Society*, 17(2), 245–256. https://www.jstor.org/stable/pdf/jeductechsoci.17.2.245.pdf

Devaney, L. (2013). Education chief wants textbooks to go digital. *eSchool News*. http://www.eschoolnews.com/2012/10/03/ education-chief-wants-textbooks-to-go-digital

Digital Technology. (n.d.). In *Dictionary.com dictionary*. https://www.dictionary.com/browse/digital-technology

Discovery Education. (2019). *Math Techbook: Problems worth solving* [Brochure]. https://www.discoveryeducation.com/wp-content/uploads/2019/03/Math-Techbook-Flyer-Overview-4-Page-Digital-2019.pdf

Durff, L., & Carter, M. (2019). Overcoming Second-Order Barriers to Technology Integration in K–5 Schools. *Journal of Educational Research and Practice, 9*(1). https://doi.org/10.5590/JERAP.2019.09.1.18

EdReports.org. (2017). *Math Techbook.* https://www.edreports.org/reports/detail/math-techbook-2017-8

Ertmer, P. (1999). Addressing First- and Second-Order Barriers to Change: Strategies for Technology Integration. *Educational Technology Research and Development, 47*(4), 47-61. http://www.jstor.org.nmu.idm.oclc.org/stable/30221096

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, *53*(4), 25–39. https://doi.org/10.1007/BF02504683

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher Technology Change. *Journal of Research on Technology in Education*, *42*(3), 255–284. https://doi.org/10.1080/15391523.2010.10782551

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, *59*(2), 423–435. https://doi.org/10.1016/j.compedu.2012.02.001

Fitzgerald, J. H., & Tisdell, C. C. (2019, June). The Impact of Educational Microcontent on the Student Learning Experience. In *Proceedings of the 2019 International Conference on Mathematics, Science and Technology Teaching and Learning* (pp. 17-22). https://dl.acm.org/doi/abs/10.1145/3348400.3348412

Gorder, L. M. (2008). A study of teacher perceptions of instructional technology integration in the classroom. *Delta Pi Epsilon Journal*, *50*(2), 63–76. https://search-ebscohostcom.nmu.idm.oclc.org/login.aspx?direct=true&db=eue&AN=508059595&site=ehost-live

Hatlevik, O. E., (2017). Examining the relationship between teachers' self-efficacy, their digital competence, strategies to evaluate information, and use of ICT at school. *Scandinavian Journal of Educational Research*, *61*(5), 555–567. https://doi-org.nmu.idm.oclc.org/10.1080/00313831.2016.1172501

Hsu, P.-S. (2016). Examining current beliefs, practices and barriers about technology integration: A case study. *TechTrends*, *60*(1), 30–40. https://doi.org/10.1007/s11528-015-0014-3

Inan, F., & Lowther, D. (2010). Factors affecting technology integration in K-12 classrooms: A path model. *Educational Technology Research and Development*, *58*(2), 137-154. http://www.jstor.org.nmu.idm.oclc.org/stable/40603153

Kampylis, P., Law, N., Punie, Y., Bocconi, S., Brečko, B., Han, S., & Miyake, N. (2013). ICT-enabled innovation for learning in Europe and Asia: Exploring conditions for sustainability, scalability and impact at system level. *Publications Office of the European Union*. http://ipts.jrc.ec.europa.eu/publi-cations/pub.cfm?id=6362.

Khan Academy 2018 annual report. (2019). Retrieved May 2, 2020, from https://khanacademyannualreport.org/

Lew, H. C. (2016). Developing and implementing "smart" mathematics textbooks in Korea: Issues and challenges. In M. Bates & Z. Usiskin (Eds.), *Digital curricula in school Mathematics* (pp. 35–51). Charlotte, NC: Information Age Publishing.

Lundblad, J. P. (2003). A review and critique of Rogers' diffusion of innovation theory as it applies to organizations. Organization Development Journal, 21(4), 50-64. https://nmu.idm.oclc.org/login?url=https://search-proquestcom.nmu.idm.oclc.org/docview/197971687?accountid=2745

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

Markauskaite, L., & Goodyear, P. (2014). Tapping into the mental resources of teachers' working knowledge: Insights into the generative power of intuitive pedagogyr. *Learning, Culture and Social Interaction*, *3*, 237–251. https://doi.org/10.1016/j.lcsi.2014.01.001

Marple, S., Jaquet, K., Laudone, A., Sewell, J., & Liepmann, K. (2019). Khan Academy in 7th grade math classes: A case study. *WestEd.org.* https://svefoundation.org/wp-content/uploads/2019/06/Khan-Case-Study_FINAL.pdf

Mendez, G. (2019, April). Deeply Digital Curriculum and Online Learning: What, Why, and How? *Distance Learning*, 16(2), 15-. Gale In Context: Opposing Viewpoints. https://search.proquest.com/openview/39e619d27101f5546829c274db69a1ee/1?pq-origsite=gscholar&cbl=29704

Mezirow, J. (1997). Transformative learning: Theory to practice. *New Directions for Adult & Continuing Education*, 1997(74), 5. https://doi-org.nmu.idm.oclc.org/10.1002/ace.7401

Miranda, H. P., & Russell, M. (2011). Understanding factors associated with teacher-directed student use of technology in elementary classrooms: A structural equation modeling approach. *British Journal of Educational Technology*, *43*(4), 652–666. https://doi.org/10.1111/j.1467-8535.2011.01228.x

Mouza, C. (2002). Learning to teach with new technology: Implications for professional development. *Journal of Research on Technology in Education*, *35*(2), 272. https://www.tandfonline.com/doi/abs/10.1080/15391523.2002.10782386

O'Halloran, K. L., Beezer, R. A., & Farmer, D. W. (2018). A new generation of mathematics textbook research and development. *ZDM*, *50*(5), 863–879. https://doi.org/10.1007/s11858-018-0959-8

Pepin, B., Choppin, J., Ruthven, K., & Sinclair, N. (2017). Digital curriculum resources in mathematics education: Foundations for change. *ZDM*, 49(5), 645–661. https://doi.org/10.1007/s11858-017-0879-z

Pittman, T., & Gaines, T. (2015). Technology integration in third, fourth and fifth grade classrooms in a Florida school district. *Educational Technology Research and Development*, *63*(4), 539–554. https://doi.org/10.1007/s11423-015-9391-8

Purcell, K., Heaps, A., Buchanan, J., & Friedrich, L. (2013). How Teachers are using technology at home and in their classroom. *Pew Research Center*, 108. https://doi.org/202.419.4500

Raymond, C. (2016). Technology integration in the classroom. *Science Insights Education*, *2016*(2016), 1–6. https://doi.org/10.15354/sie.16.re022

Remillard, J. T. (2016). Keeping an Eye on the Teacher in the Digital Curriculum Race. In M. Bates, & Z. Usiskin, (Eds.), *Digital Curricula in School Mathematics* (pp. 195-204). Greenwich, CT: Information Age Publishing. https://www.researchgate.net/profile/Janine_Remillard/publication/303802572_Keeping_an_Eye_on_the_Teacher_in_the_Digital_Curriculum_Race/links/5752ee1008ae17e65ec43053/Keeping-an-Eye-on-the-Teacher-in-the-Digital-Curriculum-Race.pdf

Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York: Free Press.

Ruthven, K. (2018). Instructional Activity and Student Interaction with Digital Resources. In L. Fan, L. Trouche, C. Qi, S. Rezat, & J. Visnovska (Eds.), *Research on Mathematics Textbooks and Teachers' Resources: Advances and Issues* (pp. 261–275). Springer International Publishing. https://doi.org/10.1007/978-3-319-73253-4_12

Taylor, R. L. (2017). *Preparing teachers to embrace educational technology* (Doctoral dissertation). Alliant International University, San Diego, California. https://search.proquest.com/openview/49c668442128ed46d8535890cdc0273d/1?pq-origsite=gscholar&cbl=18750&diss=y

Technology. (n.d.) In *Merriam-Webster.com dictionary*. https://www.merriam-webster.com/dictionary/technology

Thomas, S. (2016). Future ready learning: Reimagining the role of technology in education. 2016 National Education Technology Plan. *Office of Educational Technology, US Department of Education*. https://eric.ed.gov/?id=ED571884

U.S. Department of Education, National Center for Education Statistics. (2019). *Table 702.12. - Percentage distribution of children ages 3 to 18, by whether they have home internet access, whether they have access through computer or only smartphone, and selected child and family characteristics: 2016 and 2018.* (NCES 2017-098) https://nces.ed.gov/programs/digest/d19/tables/dt19_702.12.asp

Usdan, J., & Gottheimer, J. (2012). FCC chairman: Digital textbooks to all students in five years. *Federal Communications Commission*. http://www.fcc.gov/blog/ fcc-chairman-digital-textbooks-all-students-five-years.

Usiskin, Z. (2018). Electronic vs. Paper textbook presentations of the various aspects of mathematics. *ZDM*, *50*(5), 849–861. https://doi.org/10.1007/s11858-018-0936-2

Yin, R. K. (2018). *Case study research: Design and methods*. [Kindle version]. Retrieved from amazon.com

Zainal, Z. (2007). Case study as a research method. *Jurnal Kemanusiaan*, *5*(1). https://jurnalkemanusiaan.utm.my/index.php/kemanusiaan/article/view/165

Zhao, Y., & Frank, K. A. (2003). Factors affecting technology uses in schools: An ecological perspective. *American educational research journal*, *40*(4), 807-840. https://doi.org/10.3102%2F00028312040004807

Appendix A

Administrator Interview Protocol

1. What experience do you have with a digital curriculum for learning mathematics?
2. What benefits come from using a digital curriculum for learning mathematics?
3. What barriers have influenced or affected your experience with a digital curriculum for learning mathematics?
4. What needs exist for teachers when using a digital curriculum for learning mathematics? For students? For parents?
5. What would make use of a digital curriculum for learning mathematics more successful?
6. Is there anything about the use of digital curriculum that you would like to tell me that I did not ask you about?

Appendix B

Teacher Interview Protocol

1. What experience do you have using a digital curriculum for learning mathematics?
2. What benefits have you experienced using a digital curriculum for learning mathematics?
3. What barriers have influenced or affected your use of a digital curriculum for learning mathematics?
4. What needs exist when using a digital curriculum for learning mathematics?
5. What would make your use of a digital curriculum for learning mathematics more successful?
6. Is there anything about the use of digital curriculum that you would like to tell me that I did not ask you about?

Appendix C

Parent Interview Protocol

1. What experience do you have with the digital math program, Math Techbook, which your child uses at school for math class?
2. What things do you like about the Math Techbook program that your child uses for math?
3. Have there been any challenges for you or your child when using the digital program? If so, what were they? How do they compare to when your child was learning math with a paper-based book?
4. What do you and/or your child need help with when using a program like Math Techbook?
5. What would improve your child’s use of a digital curriculum, such as Math Techbook?
6. Is there anything about Math Techbook that you would like to tell me that I did not ask you about?

Appendix D

Student Interview Protocol

1. What experience do you have using digital curriculum, such as Math Techbook, to learn math?
2. What things do you like about using a digital curriculum, such as Math Techbook?
3. Have there been any challenges to learning with a digital curriculum? If so, what were they? How do they compare to learning math with a book?
4. What do you need help with when using a program like Math Techbook?
5. What would make using a digital curriculum, such as Math Techbook, better?
6. Is there anything about Math Techbook that you would like to tell me that I did not ask you about?

Appendix E

NMU Institutional Review Board Approval Document

Memorandum

TO: Andrew Mills
School of Education, Leadership, and Public Service

CC: Derek Anderson
School of Education, Leadership, and Public Service

FROM: Dr. Lisa Schade Eckert
Dean of Graduate Education and Research

DATE: March 13, 2020

SUBJECT: IRB Proposal HS20-1112
"One District's Stakeholders' Description of the Support and Barriers Impacting the Usage of a Digital Mathematics Curriculum"
IRB Approval Date: 3/13/2020
Expiration Date: 3/12/2021
Proposed Project Dates: 2/24/2020 – 5/1/2020

Your proposal "One District's Stakeholders' Description of the Support and Barriers Impacting the Usage of a Digital Mathematics Curriculum" has been approved by the NMU Institutional Review Board. Include your proposal number (HS20-1112) on all research materials and on any correspondence regarding this project.

A. If a subject suffers an injury during research, or if there is an incident of non-compliance with IRB policies and procedures, you must take immediate action to assist the subject and notify the IRB chair (dereande@nmu.edu) and NMU's IRB administrator (leckert@nmu.edu) within 48 hours. Additionally, you must complete an Unanticipated Problem or Adverse Event Form for Research Involving Human Subjects

B. Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding. Informed consent must continue throughout the project via a dialogue between the researcher and research participant.

C. If you find that modifications of investigators, methods, or procedures are necessary, you must submit a Project Modification Form for Research Involving Human Subjects before collecting data.

D. If you complete your project within 12 months from the date of your approval notification, you must submit a Project Completion Form for Research Involving Human Subjects. If you do not complete your project within 12 months from the date of your approval notification, you must submit a Project Renewal Form for Research Involving Human Subjects. You may apply for a one-year project renewal up to four

times. Failure to submit a Project Completion Form or Project Renewal Form within 12 months from the date of your approval notification will result in a suspension of Human Subjects Research privileges for all investigators listed on the application until the form is submitted and approved.

Janelle N. Taylor
Coordinator of Graduate Student and Research Affairs
Graduate Education and Research
Northern Michigan University
906-227-1407
1401 Presque Isle Ave, Marquette, MI 49855
http://www.nmu.edu/graduatestudies/

Appendix F

NMU IRB Modification Approval Document

MEMORANDUM

TO: Andrew Mills
School of Education, Leadership, and Public Service

CC: Derek Anderson
School of Education, Leadership, and Public Service

DATE: March 23, 2020

FROM: Lisa Schade Eckert,
Dean of Graduate Education and Research

RE: Modification to HS20-1112
Original IRB Approval Date: 3/13/2020
Modification Approval Date: 3/23/2020
"One District's Stakeholders' Description of the Support and Barriers Impacting the Usage of a Digital Mathematics Curriculum"

Your modification for the project "One District's Stakeholders' Description of the Support and Barriers Impacting the Usage of a Digital Mathematics Curriculum" has been approved by the Northern Michigan University Institutional Review Board. Please include your proposal number (HS20-1112) on all research materials and on any correspondence regarding this project.

Any additional personnel changes or revisions to your approved research plan must be approved by the IRB prior to implementation. Unless specified otherwise, all previous requirements included in your original approval notice remain in effect.

If you have any questions, please contact the IRB at hsrr@nmu.edu.

Janelle N. Taylor
Coordinator of Graduate Student and Research Affairs
Graduate Education and Research
Northern Michigan University
906-227-1407
1401 Presque Isle Ave, Marquette, MI 49855
http://www.nmu.edu/graduatestudies/