Increasing Math Knowledge in 3rd Grade: Evaluating Student Use & Teacher Perceptions of Imagine Math

Paoze Lee

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INCREASING MATH KNOWLEDGE IN 3RD GRADE: EVALUATING STUDENT USE & TEACHER PERCEPTIONS OF IMAGINE MATH

by

Paoze Lee

Bachelor of Arts,
California State University of Fresno, 1997

Master of Science,
National University, 2008

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Accepted by:
Michael Grant, Major Professor
Ismahan Arslan-Ari, Committee Member
Hengtao Tang, Committee Member
Anna Clifford, Committee Member
Cheryl L. Addy, Interim Vice Provost and Dean of the Graduate School
DEDICATION

To Ruge, Ansel, Autumn, Gigi, Edison, Pajzaub, family and friends.
ACKNOWLEDGEMENTS

I would like to thank my mentor, Dr. Grant for his dedication, patience and guidance. I would also like to thank my children, family and Pajzaub for their patience, love, and support throughout this whole process.
ABSTRACT

Students across the nation struggle with learning mathematics for a variety of reasons such as the abstract nature, there is only one correct answer and how math is foundational. With the recent increase in the use of digital programs, school districts across the nation have turned to digital math programs for math intervention and learning. School district leaders must weigh costs, effectiveness, and teacher perceptions. Eighty-seven percent of the third grade students at Reyes Elementary nearly met or did not meet California math standards, prompting the school to adopt Imagine Math. The purpose of this research was to evaluate if Imagine Math can affect students’ knowledge. The two research questions were (1) what is the effect of the Imagine Math program on students’ math knowledge and (2) what are teachers’ perceptions of using Imagine Math for student learning.

The evaluation research design provided data collection which included a pre and posttest diagnostic benchmark assessment from third grade students (n = 117) on three third grade math standards: CCSS Math Content 3. Numbers and Operations in Base Ten (NBT), CCSS Math Content 3. Measurement and Data (MD), and CCSS Math Content 3. Orders and Algebraic Thinking (OA); and a teacher focus group interview. There was significant growth for standards NBT and OA, but standard MD showed no significant growth. Two themes emerged from the teacher focus group interview: teachers valued Imagine Math for student engagement and independent learning but were unsure of its impact on mathematics learning and teachers held different views on its use.
and features. These findings indicated that IM worked for two of the three measured standards and teachers were unsure of the impact of IM on students’ math knowledge. According to the teachers, students were engaged and motivated when using IM, IM was needed for students who were below grade level and independent learning, but teachers had mixed feelings about reporting and navigation features.

The implications for this study included essential features for digital math games as a supplement for math learning and future research on specific state standardized tests.

*Keywords:* digital math programs, digital game-based learning, math achievement, immediate feedback, computer assisted intervention
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CHAPTER 1

INTRODUCTION

National Context

According to the 2017 National Assessment of Education Progress (NAEP), there have been little to no gains for math scores for students in grades 4, 8 and 12 (Hechinger Report, 2018). California ranks 47th among the 50 states for 4th grade math scores. Though California tests all their students in grades 3 through 8 and 11, the NAEP only tracks grades 4 and 8, nationally. Nationally, California scored below “Basic” on the mathematics report card for NAEP on a scale that includes Basic, Proficient, and Advanced (Nation’s Report Card, 2017). Sixty percent of the nation’s fourth graders lack mathematics proficiency (National Center for Education Statistics, 2016).

Computer-based technologies have been seen as one way to address these deficiencies. In terms of teaching and learning experiences, teachers and students reported that 99 percent of them had access to technology devices to help with learning math (Nations Report Card, 2017). Eighty-one percent of eighth grade students reported using a technology device at least twice a week to help them learn math and 71 percent reported using a technology device to review mathematics (Nation’s Report Card, 2017). In terms of working in pairs or groups, 81 percent reported doing such and 83 percent of the teachers reported spending at least three to seven hours a week on math (Nations Report Card, 2017). Eighty-five percent of students reported teachers having them create
equations and 86% of the students reported having teachers that made them interpret, analyze and understand patterns and graphs. Students that enjoyed complex math problems fared much better than students who did not (Nation’s Report Card, 2017).

There have been studies that have linked success in middle school math such as Algebra to math fact fluency (e.g., Geary, 2013; Nelson et al., 2016; Cozad & Riccomini, 2016; Geary et al., 2013). Such studies include the use of educational digital game-based learning tools that improve math fact fluency (Berrett & Carter, 2017; Rave & Golightly, 2014; NMAP, 2008). The use of educational digital game-based learning tools helps improve math fact fluency because students are engaged, immediate feedback is provided, and students are motivated (Burns, et al., 2012; Duhon, House & Stinnett, 2012; Kanive et al., 2014; Musti-Rao & Plati, 2015). So, with increased access to computer-based technologies such as educational digital game-based learning, students’ math scores may be improved when math fact fluency is also improved.

**Local Context**

The Reyes Unified School District scored last in the Mercey County area. The district had a math percentage of 12% overall students in grades 3-8 and 11 that met or exceeded the standards. This was an increase of 24% from the last state analysis in 2015 (CAASPP, 2023). The state average for students meeting or exceeding state standards is 38.65%. The district is 26% below the state average, and 12% below the county average which causes concern for the district. The county average for students meeting or exceeding state standards is 24.82% (Merced Sun-Star, 2019). The district has 1 high school, 1 middle school, 2 elementary schools and 1 continuation school. The two
Elementary schools are broken into one that is PK-2, and the other is grades 3-5. Reyes Elementary School has an enrollment of 540 students, with 89% socioeconomically disadvantaged, 34% English Learners and 0.4% foster youth (CA School Dashboard, 2023).

The teachers at Reyes Elementary spend an average of 1.5 hours on math daily and have implemented at least 30 minutes a week on a new math supplemental program, Imagine Math. Teachers at Reyes can spend more than 30 minutes with Imagine Math if they prefer. Once a month teachers meet in their professional learning communities and discuss math and English Language standards and challenges. This provides an opportunity for the teachers to share what works and what areas need more focus. The principal at Reyes meets monthly with the Curriculum Council, which includes other principals and district administration.

**Statement of the Problem**

Eighty-seven percent of the third grade students achieved “Standard Nearly Met” or “Standard Not Met” at Reyes Elementary for the 2021 school year (Ed-data.org, 2023; CAASPP, 2023). There are various reasons why students struggle with math, such as the abstract nature of math, only one right answer, math is foundational, student expectations of math, memorization skills required, and practice (National Council of Teachers of Mathematics, 2007). Reyes Elementary partnered with Imagine Learning for the Imagine Math application to help students with their math struggles. There is an increasing amount of online learning programs in the K-12 environment (Paadre, 2011). These studies have shown a positive impact of online digital programs on student learning
(Outhwaite & Faulder 2019). Sharp and Hamil (2011) pointed out that these online math programs provide an engaging, interactive approach for students. Other studies have shown that interventions such as the Imagine Math program have proven to be successful for math fluency and shown an increase in state standardized math scores (Berrett & Carter, 2018; SEG, 2019).

**Purpose Statement**

The purpose of this research was to evaluate if Imagine Math, an educational digital game-based learning tool, affects students’ math knowledge.

**Research Questions**

The following were the research questions for this study:

1. What is the effect of the Imagine Math program on students’ math knowledge?

2. What are teachers’ perceptions of using Imagine Math for student learning?

**Researcher Subjectivities and Positionality**

I decided to pursue a graduate degree in educational technology because of two reasons: 1) my interest in how engaging technology was to teaching and learning and 2) my financial interests in moving upon the teacher step/column. This decision to pursue a graduate degree was after I got comfortable with teaching and realized that I could do more by integrating technology into my teaching and be a resource to my teacher colleagues.

I came to this country as a refugee and did not know English. At a very young age, I believed that I could achieve anything I wanted. I achieved most of those things...
such as being an engineer, teacher, and now, technology director. I am a firm believer in modeling expectations, staying positive and using actions rather than words. These characteristics have served me well with my career as an educational technologist.

I have some personal characteristics that would present challenges for me to be an “ideal” educational technology professional. Some of those characteristics include my inability to tell people “No.” I am a “people pleaser” and I find myself always trying to make everyone happy. In short, I wish that I was a better change agent. I would have to say that I have certain identities that make my job easier such as my willingness to try new things; my openness to hear different sides; and my can-do attitude. I strongly believe that when it comes to educational technology, one must believe that all teachers can learn new technology, are creative, and persistent.

I am interested in finding out how students learn with an online software program such as Imagine Math. I think that this younger generation learns better when they are physically engaged and see instant rewards, whether that be just advancing to a next level in a game or digital ribbons. I believe that this is the future of learning and needs more research.

I am a firm believer that all children can learn and that educators should provide tools necessary for our students to be successful in academics and society. Math is a general basic skill that is needed and should be taught at all levels, TK-12. I believe that technology integration engages this generation of learners more than any other generation. In my years of teaching, I find my last statement to be evident and as a current technology director, teachers have shared similar experiences. Though I
understand that there are teachers and students who believe that technology integration aids in learning, there are others who believe that technology has curbed student learning. I believe that this is a small number of teachers, and these teachers are less likely to use technology in the classroom.

**Researcher’s Paradigm and Positionality**

My research paradigm is pragmatic because I want to find out “what works.” This pragmatic approach helps me use an evaluation research design to help me better understand my research problem. I really want to know if Imagine Math is a good financial decision as well as a great instructional program. I believe that if I analyze a pre and post benchmark assessment with student data and teacher focus group interview, I would be able to draw a conclusion on the usefulness of the program, how successful it is, and provide more research on this topic.

My positionality with my research is insider in collaboration with other insiders. Herr and Anderson state that this type of positionality leads to professional or organization transformation (Herr and Anderson, 2005). I plan to work with the site principal and teachers at Reyes Elementary and because of my position, there might be certain biases.

I received approval from our Superintendent on this research as it is beneficial to the district. I met with the principal and teachers at Reyes Elementary. I explained to them the purpose of the research and discussed how this will benefit our students and district. I provided a brief summary of the research and reminded them that I will do my best to not impact the instructional time. I sent auto-dialers to parents about the research
and reminded them that there will be no identifiable information about the students. I provided this information to the board of trustees before and after the results.
Definition of Terms

**Adaptivity:** Adaptivity is the capability of the game to engage each learner in a way that reflects his specific situation. (Plass et al., 2015)

**Computer assisted intervention (CAI):** CAI is any type of computer software or technology designed to display instructional material and monitor learning progress in any educational topic. (Cates, 2005).

**Digital game-based learning (DGBL):** This is any digital game that promotes learning, engages the learner, and helps the player solve problems. (Issacs, 2015; Kapp, 2013; Plass, Perlin, & Nordlinger, 2010)

**Digital math programs:** These are digital tools used to instruct mathematics. (Berrett, 2017)

**Engagement:** This is the voluntary use of high functioning learning strategies such as paying attention, connecting, planning and monitoring. (Turner, 1995).

**Gamification:** Gamification is the use of game-based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems. (Kapp, 2013)

**Graceful failure:** This is when failure is by design and essential step in the learning process for DGBL. (Kapur, 2008; Kapur & Bielaczyc, 2012; Kapur & Kinzer, 2009)

**Immediate feedback:** This is computer assisted intervention feedback that is instantaneous. (Berrett, 2017)
**Math achievement**: This is the competency shown by the student in the subject mathematics (Pandey, 2017)

**Motivation**: These are the reasons why learners are willing to perform certain tasks (Lai, 2011)
CHAPTER 2
LITERATURE REVIEW

In this chapter, I will review the literature that relates to the topics of this study. To reiterate, the purpose of this research was to evaluate if Imagine Math affects students’ math knowledge. The two research questions that guided this study were:

1. What is the effect of Imagine Math on students’ knowledge?

2. What are teachers' perceptions of using Imagine Math for student learning?

In order to connect the literature review to the study, I will first discuss how I found the literature, what search terms or phrases I used, what databases were researched, how much of the research was within the last five years, and how the research was mined from the references.

Methodology

The key terms used for this literature review included digital math games, digital game-based learning (DGBL), handheld gaming consoles, math fluency, math instruction in K-12, gamification and motivation, and Imagine Math. Some databases refined the search when some or combinations of the key terms were used, but because DGBL in mathematics is a new and developing area of study, not much research was available. This was especially true when it came to the topic of Imagine Math and Think Through Math as those are both new software in digital game-based learning environments.
There were some databases used for this literature review. Those include the University of South Carolina (USC) e-library, ProQuest, ERIC, Google Scholar, and Education Source. Most of the database searches stemmed from the USC e-library.

Of the studies compiled for this literature review, 9 are within the last five years. They range from math fluency to learning theories in digital mathematics education and include gamification and digital game-based learning topics. Four of the nine literature reviews articles within the five-year period are about Imagine Math. There are relational studies that describe effective math instruction. Those relational studies are mostly within the ten-year period with a few dating back to the 1970s.

When I mined the references of relevant articles, it led to additional sources, especially those about effective math instruction. That provided more insight on what components of math instruction and the connection to digital games were. In the following sections, I will cover (a) digital games, (b) definition of digital based learning (c) characteristics of successful digital games which include motivation, engagement, adaptivity and graceful failure. The goal is to connect learning theories and digital games in the realm of math education and discuss how teachers and staff perceive learning with digital games. This will provide the rationale to use a digital game such as Imagine Math as an intervention and a look into current literature on Imagine Math and its impact on state standardized tests.

**Digital Games**

With the rise of digital games in the last 30 years, practitioners in K-12 education have had to adjust to meet this new generation of digital learners. School districts and
educators have explored digital math programs for math intervention and learning (Egenfeldt-Nielsen, 2005; Federation of American Scientists, 2006; Mitchell & Savill-Smith, 2004; Coller & Scott, 2009; Ke & Grabowski, 2007, Takeuchi & Vaala, 2014). This, coupled with research on digital games and learning, has provided educators with some insight on how interventions such as Imagine Math could be used in mathematics education. In the following sections, I will define digital game-based learning (DGBL) and establish the characteristics of successful digital games.

**Definition**

The definitions of DGBL mostly emphasize that it is a type of game play with defined learning outcomes (Shaffer, Halverson, Squire, & Gee, 2005). Similarly, another definition was that gamification involved the use of game elements, such as incentive systems, to motivate players to engage in a task that they otherwise would not find attractive (Plass, Homer, & Kinzer, 2015). In the following sections, I will provide definitions for both gamification and DGBL and then propose my own definition.

Gamification as defined by Kapp (2013, p. 125) is the use of “game-based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems.” Other authors point out that gamification is any game that provides the player an opportunity to solve problems in an artificial world (Alsawaier, 2017; Connolly, Boyle, MacArthur, Hainey & Boyle, 2012). This solving of problems extends out into the business and other fields and provides a social aspect as Simoes et al (2013) contend. In the educational context, gamification requires critical thinking (Folmar, 2015). This approach lends itself to reteaching teachers on their pedagogical
practices (Zickerman, 2010). The result of gamification being the ability to critically think and solve the problem that was presented.

Salen and Zimmerman (2004) define games as a system by which players participate in artificial conflict, defined by a set of rules and result in a quantifiable outcome. According to Keeler (2014), DGBL is a process when students play games to learn the content. This educational content has a beginning and an end and is short lived when it comes to the engagement factor (Alsawaier, 2017). Issacs (2015) states that educational DGBL “relates to the use of games to enhance the learning, pp.1-2”. It is important to note that not all games are digital but could produce similar desired learning outcomes (Plass, Perlin, & Nordlinger, 2010). For the purposes of this study, I propose a shortened, combined definition as educational DGBL will be defined as any digital game that promotes learning, engages the learner, and helps the player solve problems.

**Characteristics of Successful Digital Games**

There are characteristics that are found in all successful digital games. Successful digital games are good for learning because they rely on learning theories. But first, the characteristics of successful digital games will be discussed. These characteristics are examined through studies with use of DGBL and their positive effects on learners (Groff, Howells, & Cranmer, 2010; Gros, 2007; Proulx, Romero, & Arnab, 2017; Ritzko & Robinson, 2006). This section will address those characteristics of good digital games, which include motivation, engagement, adaptivity, and graceful failure (Plass, Homer, & Kinzer, 2015). The combination of these characteristics is what make good games successful, which includes educational DGBL. For example, a game could include
motivation, engagement, and graceful failure, but not be adaptive. Because the game does not allow the learner to learn at their pace, the game would eventually disengage the learner and they would quit. Without the characteristic of adaptivity, the game is not successful.

**Motivation**

Motivation, as defined by Lai (2011), are the reasons why learners are willing to perform certain behaviors. Lai (2011) contends that motivation involves a recipe of factors such as beliefs, perceptions, values, interests, and actions. All digital games must provide an entertainment factor that motivates the player to want to play (Alsawaier, 2017). This motivational function of games is their most frequently cited characteristic (Plass, Homer, & Kinzer, 2015). Plass et. al (2015) argue that games with entertainment value have been able to motivate learners to stay engaged over long periods through a series of game features that are of a motivational nature. These game features include certain incentive structures, such as stars, points, leaderboards, badges, and trophies, as well as game mechanics and activities that learners enjoy or find interesting (Hidi & Renninger, 2006; Rothans & Schmidt, 2011). As players play educational DGBL, they are cognitively engaged and the game features are more likely to help the learner achieve the learning goal (Plass et al, 2015).

**Engagement**

Digital games for learning allow for a wide range of ways to engage learners (Plass et al, 2015). Engagement, as defined by Turner (1995), is the voluntary use of high functioning learning strategies such as paying attention, connection, planning, and
monitoring. Plass et al. (2015) contend that there is a fourth type of engagement, social cultural engagement. These types of engagement foster cognitive engagement to the learner with the learning mechanic (Plass et al., 2015). While researchers such as Csikzentmihalyi (1997) argue that once a player is engaged in a task, the player becomes deeply involved and might be impervious to all that surrounds her. This type of engagement, coupled with strong motivation in DGBL, could lead to successful learning experiences (Davis & McPartland, 2012).

Adaptivity

According to Plass, Homer, and Kinzer (2015), “learner engagement is facilitated in part by the many ways of making a game adaptive, customizable by the player, or personalized” (Andersen, 2012; Leutner, 1993; Plass, Chun, Mayer & Leutner, 1998; Turkay & Kinzer, 2013). Adaptivity is the capability of the game to engage each learner in a way that reflects his specific situation (Plass et al., 2015). A few factors influence adaptivity such as the learner’s prior knowledge, how challenging the tasks are, and the guided responses provided to the learner (Plass et al., 2015).

Graceful Failure

Another positive characteristic of DGBL is that it allows for graceful failure. Rather than describing it as an undesirable outcome, failure is by design an expected and sometimes even necessary step in the learning process (Kapur, 2008; Kapur & Bielaczyc, 2012; Kapur & Kinzer, 2009; Plass, Perlin, et al., 2010). This allows learners to fail and learn in the comfort and security of their own space. The learner is also provided opportunities to learn on his own and can achieve at his own pace, which allows for
differentiation of the learning. This graceful failure, combined with adaptivity, engagement, and motivation, allows the learner to take ownership of his own learning (Plass et al., 2015).

In the previous sections, the purpose and research questions were discussed. Then, a definition was given for digital game-based learning along with what characteristics were found in good digital games for learning. In the following section, I will cover the meta-theoretical model of game-based learning, how motivation impacts digital game-based learning, what the self-determination theory states about motivation, and why it is important to have flow type outcomes for DGBL.

Learning Theories and Digital Games

There are three main theories of learning: cognitivism, behaviorism, and constructivism. These three main learning theories help educators tailor instruction to meet the needs of students. In digital games, designers use similar approaches. Plass et al. (2015) contend that [game] designers use behaviorist elements, cognitivist elements, constructivist elements, and combinations of all three when designing games. In the sections that follow, I will explain (a) learning theory characteristics, (b) the combination of those learning theories in game-based learning, or the meta-theoretical model of game-based learning, (c) the self-determination theory, and (d) flow-type outcomes.

Learning Theory Characteristics

DGBL has three learning theory characteristics associated with it: behaviorism, cognitivism, and constructivism. Behaviorist learning theory was popularized by Watson and Skinner at the turn of the 20th century. Skinner (1938) explained behaviorists
learning theory as the causes of action and its consequences and called this operant conditioning. Today, it is also known as reinforcement theory and whenever one wants to shape another’s behavior, all they must do is reinforce it with rewards. This learning theory is evident in the popular commercial game, *Fortnite*, because the players gain instant rewards by building their fort, cooperating with each other to fend off zombies, picking up materials and tools to help their cause. As the player clears obstacles, the player can pick up new tools that would help them build and craft needed items.

Piaget (1962) defines cognitive development as the play of children as they progress through stages. Cognitivism is also found in Fortnite. Players within the game get to set their own goals, design their own forts and assume control and responsibility of their teams. As the players in Fortnite progress and go through different learning experiences, cognitive development happens. This cognitive development depends on the interaction of the players within the game as they learn the game mechanics, and are provided feedback (Plass et al, 2015).

The other learning theory characteristic that is found in Fortnite is constructivism. This theory hinges on the idea that the learner constructs their own understanding and meaning of the world (Bada, 2015). The learner internalizes new learning which becomes prior knowledge and then furthers learning with that prior knowledge (Bada, 2015). This theory supports the idea of student-centered learning because the student should construct and control their learning. The player constructs a better understanding of this game as they play it more and more and learn from the other players. The players learn how to navigate and negotiate the tasks throughout by pulling from prior knowledge. An example of this would be destroying the first machines that the player
sees. Upon destroying machines, the player will realize that they can use those parts for other things such as fortifying their forts.

**Meta-theoretical Model of Game-Based Learning**

Plass et al. (2015) contend that “instead of a comprehensive theory of learning, the basic structure virtually all games appear to have” is entertainment (p. 261). They further argue that structure consists of three key elements: a challenge, a response, and feedback (Plass et al., 2015) and is really a set of all three of those intertwining in the features of game design. The learners must be presented a challenge within the game design, provide a response, and then be given feedback and the game design is a combination of the three learning theories, a “meta-theoretical model” (Plass et al., 2015). This meta-theoretical model incorporates the different learning theories depending on the type of challenge, the feedback it gives, and the response that is constructed by the learner. The learning theory used depends on the desired outcome. For example, if the desired learning goal is for the learner to construct meaning, the responses would be geared towards digital tools that would allow the learner the freedom to construct their own meaning (Plass et al., 2015).

This is found in the game *Fortnite*, whereby the players can choose tools along the way to build their own forts to fortify their survival and find better ways to destroy the zombies. After several trials of this, the player will learn to construct meaning of the *Fortnite* world and be able to navigate and negotiate the tasks throughout by drawing upon prior knowledge. If the desired learning goal was behaviorist in nature, the
responses and feedback would be like multiple choice answers—thus providing the learner with a reward or reinforcement of the learning.

**Self-Determination Theory**

Kowal and Fortier (1999) found that participants who had a self-determined motivation reached the highest states of flow experience. This was coined by Deci and Ryan (2008) as self-determination theory (SDT). SDT has three main tenets: autonomy, competence, and relatedness (Deci & Ryan, 2008; Seaborn & Fels, 2015). Lee (2005) found that students with higher self-determined motivation were more likely to reach the flow experience and to be deeply engaged in their task. For example, according to Reeve (2002) students benefit from having a teacher who allows them to have a certain level of autonomy in the classroom, which seems to allow students to develop their orientation to grow and feel more competent, more confident, more open-minded, and creative. In terms of relatedness, once the learner is self-determined to complete the DGBL, the learner will feel connected to other learners in the virtual world—in other words, a sense of belonging to that “group” (Plass et. al., 2015). In terms of game design for DGBL, this is another layer of complexity which if not connected correctly, the learning can be missed completely (Deci & Ryan, 2008).

**Flow-Type Outcomes**

According to Csikszentmihalyi (1990), flow can be defined as a complete state of cognitive absorption or engagement in a task, in which the individual is not affected by thoughts or emotions unrelated to the task. Per Plass et al., (2015) good games target the right amount of challenge but allow for flow type of outcomes. For example, flow type
outcomes lead the learner to the player’s zone of proximal development (Plass et al., 2015). This zone of proximal development according to Vygotsky (1978) is the leading factor in child development. As children play within their zone of development, learning comes from their social interactions (Nicolopoulou, 1993). This according to Plass et al (2015) connects the learning for DGBL and is found in well-designed games.

Math Instruction

According to the Hechinger Report (2018), students across the nation are struggling with learning mathematics due to the abstract nature of math, constraint of only one correct answer, how math concepts build upon one another, requirement of memorization skills, and required practice. In the following sections, I will review what recent researchers have found about (a) effective math fluency, (b) automaticity, (c) drill and practice, and (d) immediate and corrective feedback. Within each section, current research in digital games and how digital games impact those effective strategies will be covered.

Effective Math Fluency

Math fact fluency occurs when the learner can respond rapidly to the four math fact operations: multiplication, addition, subtraction, and division. (Musti-Rao et al, 2015; Nelson et al, 2016). The development of fluency is a series of steps that leaves behind old memorization techniques for new and quicker ones and through repetition of this process (Baroody, 2006). For example, a student who becomes more fluent leaves behind old methods of calculation such as finger counting and eventually relies entirely on semantic memory (Lemaire & Siegler, 1995). Students acquire math fact fluency at
different rates and therefore need varying degrees of practice before achieving fluency and automaticity for all math facts (Burns et al., 2015). Another study suggests that students who do not develop fact fluency by the end of the fifth grade might not develop fluency and automaticity in later grades (Steel & Funnell, 2001). There are studies that agree that math fact fluency in elementary grades is foundational for success in more complex mathematics such as algebra (Cozad & Riccomini, 2016; Geary, 2011; Geary et al., 2013; Nelson et al., 2016).

**Automaticity**

Berrett and Carter (2017) state that “automaticity in math fact recall is particularly important for later math success as the development of automaticity is directly related to reductions in working memory and cognitive loads” (p. 224). This reduction in cognitive load allows for the learner to acquire and perform more complex math problems and allows for math fluency (Fuchs et al., 2005; Parkhurst et al. 2010). Students need to be able to learn at different ability levels; thus, teaching basic math requires that teachers can adapt the learning needs of individual students (Berrett & Carter, 2017). An example of this is when an upper elementary, 5th or 6th grade student automatically knows their multiplication facts and is easily able to perform order of operations—thus decreasing the time for the whole math problem.

In the Imagine Math (IM) program, students are continually given problems before they can move on to the next level. As the student is provided more opportunity to work on those math problems, they practice automaticity with the four domains: multiplication, addition, subtraction, and division. This drill and practice should develop
the students’ automaticity if implemented with fidelity (NMAP, 2008). Another study reported that computer-based math facts learning nearly doubled student growth in math fact fluency (Burns et al., 2012).

Drill and Practice

Another component of effective math instruction is drill and practice (Burns et al., 2015). According to Barrett and Carter (2018), teachers must provide enough drill and practice for students to master math facts, curricula must include practice activities with ample opportunities to respond, and teachers must ensure that students have adequate time to engage with those activities. When students practice math facts, the learning must be gradual and build from foundational concepts. This ratio of drawing on prior knowledge such as drill and practice allows the learner to incorporate newer learning at a good ratio (Burns et al., 2015).

Like the last section on automaticity, the repetitive nature of IM allows ample opportunity for students to develop math fact fluency. In a study done by Rave and Golightly (2014), students who used computer-aided instruction saw a 22% increase in their test scores. It is important to stress that students must be exposed to ample opportunity with regular intervals (NMAP, 2008).

Immediate and Corrective Feedback

In classrooms, teachers must ensure that all students receive immediate corrective feedback when practicing math facts. Feedback given after students have completed a practice session is not likely to be as effective. Feedback is a critical component of programs designed to build math fact fluency (NMAP, 2008). When students practice
math facts, they should have ample opportunities to practice with immediate feedback to prevent them from practicing incorrect responses (Berrett & Carter, 2017). Mastery develops and strengthens as students practice responding correctly to math fact prompts (Fuchs et al., 2008). The lack of immediate feedback, students would assume that they have the correct answer and risk becoming fluent with wrong answers (Hawkins et al., 2017). The longer the teacher allows this to happen, the harder it is to correct (NMAP, 2008). This is due to the notion that working memory and the ability to process information have been established as an important part of math facts fluency (Camos & Barrouillei, 2018; Hansena et al., 2015; Musti-Rao et al., 2015).

In the IM program, students are provided immediate feedback when they provide a wrong answer. In the multiplication part, like all the other parts, the program provides “modeling of correct answers, and immediate, corrective feedback for errors” (Berrett & Carter, 2017, p. 226).

Digital Games in Math Education

There has been an increased rise in the use of digital math games in education (Takeuchi & Vaala, 2014). Imagine Math and Think Through Math are examples of those digital math games in education and are both part of the Imagine Learning family of digital online learning solutions. In the sections below, I will review (a) the history of Imagine Math and Think Through Math, (b) research methods for DGBL and (c) teacher perceptions about the use of DGBL. Imagine Math and Think Through Math are both online digital math learning programs designed to increase math fluency in K-12 education. In 2014, Gibson Consulting, in accordance with Texas Education Agency, did
a study that showed the impact of Think Through Math usage and the STAAR-Mathematics test. In California, the SEG Measurement group conducted a study showing the relationship between Imagine Math usage and California math standards test. In the following sections, I will cover (a) Imagine Math and Think Through Math History, (b) research methods of DGBL, (c) teacher perceptions about DGBL, (d) digital games usage by teachers and (e) teacher perceptions of digital games as intervention.

**Imagine Math and Think Through Math History**

Think Through Math is an online, adaptive mathematics program designed to supplement classroom instruction. The program has embedded student motivators built into the lessons. Imagine Math and Think Through Math are made from the same parent company, Imagine Learning and both are really the same product (Weld North, 2016). Think Through Math was acquired by Imagine Learning in October 2016 under Pittsburg-based Think Through Learning, Inc. (Weld North, 2016). Imagine Math evolved from Think Through Math and Imagine Math is the more widely used name after this acquisition.

Imagine Math and Think Through Math incorporate all those successful DGBL characteristics such as motivation and engagement, adaptivity, graceful failure. According to Snyder (2016), when students use Imagine Math, they perceive Imagine Math as a fun game and do not realize they are learning. This continual play opens ample opportunities for students to practice math fact fluency skills (Berrett & Carter, 2017; NMAP 2008). This also aligns with flow type outcomes found in successful digital games. Imagine Math provides graceful failure and immediate feedback when students
attempt problems. If the student does not get the correct answer, the student is provided immediate feedback and fails in their own safe space (Berrett & Carter, 2017). Imagine Math does allow students to adjust and tailor the learning to their comprehension level thereby providing adaptivity. With all these successful DGBL traits, the verdict is still not out on Imagine Math and more research must be done.

**Research Methods of Digital Game-Based Learning**

It is worthwhile to look at what research methods have been used for the effectiveness of educational DGBL. According to All, Nunez-Castellar, and Van Looy (2014), there have been a variety of methods used for measuring the effectiveness of DGBL. All et al (2014), contend that the most implemented study designs for DGBL are quasi-experimental and survey-based but those studies prove inconclusive. This inconclusiveness provides a lack of sound empirical evidence and has led to the use of different outcome measures for assessing the effectiveness of DGBL (O’Neil, Wainess, Baker, 2005). All et al. (2014) state that there must be a common methodology for assessing the effectiveness of DGBL so that results could be compared; thus, providing more general claims on DGBL. All et al. (2014) conclude that this common baseline comparison would pave the way for future research and methodology.

**Teacher Perceptions about Digital Game-Based Learning**

Teacher perceptions about DGBL are important because teachers direct the instruction daily. If teachers are comfortable with the use of digital games in learning, then they would be more willing to expose their students to digital games for learning. The below sections will cover how teachers perceive: (a) digital games usage, (b) digital
games as an intervention, (c) influence their teaching practices and (d) DGBL was easy to use and promoted student learning.

**Digital Games Usage by Teachers.** A study conducted by the Joan Ganz Cooney Center revealed that most game-using teachers were using shorter-form genres, such as drill-and-practice, trivia, and puzzle games (An, 2017). Few teachers were using immersive learning games (Takeuchi & Vaala, 2014). DGBL experts believe that the true power of digital games lies in their ability to provide students with situated learning experiences and foster real-world skills (Gee, 2005; Shaffer et al, 2005; Van Eck, 2015). However, many teachers tend to view digital games merely as motivation tools or rewards (Gaudelli and Taylor, 2011; Schrader et al, 2006). This might cause teachers to use DGBL less as they see it only as a reward.

**Teacher Perceptions of Digital Games as an Intervention.** In a study conducted by An (2017), teachers believed that digital games are an effective way to teach real-world skills. Snyder (2016) found that teachers like to use Think Through Math as an intervention. The largest percent gain for student growth was when Think Through Math was used for acceleration. Some teachers used it for monitoring student progress and a small percentage of teachers used Think Through Math to group students (Snyder et al., 2016). In another study, a high percentage of teachers perceived digital games as a supplemental learning opportunity (Easterling, 2021). This study stated that more teacher professional development would assist teachers in using DGBL as a supplemental learning resource (Easterling, 2021). The recommendation from the study concluded that teachers best trained on how to use DGBL would more likely use it as an intervention or supplement.
Teacher Perceptions Influence Their Teaching Practices. How teachers behave is a direct correlation between their beliefs and perceptions about the use of DGBL (An, 2017; De Grove, Bourgonjon, De Smet & Van Looy, 2013; Ertmer, 2005). These perceptions in turn influence their teaching practices (Gaudelli & Taylor, 2011). The more teachers accept DGBL, the better they are to integrate and adapt DGBL to their students’ learning. This could also be attributed to how confident teachers feel about using the digital game. This confidence comes from being familiar with the digital game and as some studies have suggested, the more the teacher plays the game, the more likely the teacher is to integrate the digital game in the classroom (An, 2017; Easterling, 2021).

Teachers Liked Digital Games That Were Easy to Use and Promoted Student Learning. Teachers like to use digital games that are easy to use and they can easily integrate into their classroom (Backlund & Hendrix, 2013; Becker, 2007; Becker & Jacobsen, 2005; Girard et al., 2013). By the term easy to use, I am referring to the notion that teachers did not require substantial professional development to learn how to use, navigate, or manage a digital game. These technical features in digital games can influence teacher perceptions and depending how easy those features are to navigate, determines a teacher’s use (Hayak & Avidov-Ungar, 2020; Peddycord-Liu et al., 2019). For example, teachers used reporting features in a digital game to help drive their teaching practices because the reporting features were easy to use (Peddycord-Liu et al., 2019). And if those features were easy to use and promoted student learning, teachers were more likely to use the digital game (Becker, 2007; Becker & Jacobsen, 2005). Teachers are more likely to use digital games that promote student learning because they
know that digital games offer engagement where traditional learning methods have lacked (Becker, 2007; Groff et al., 2010).

Chapter Summary

The purpose of this evaluation research was to determine if Imagine Math impacts student’s math knowledge and what teachers’ perceptions are about Imagine Math. The research questions posed at the beginning of this literature review were to look at both the quantitative and qualitative nature of the IM program regarding performance and teacher perceptions.

There are elements for successful digital games for learning and those included motivational function, engagement, adaptivity and graceful failure. For the digital game to be useful in learning, the digital game had to ascribe to certain components of the meta-theoretical model of game-based learning. These components included a challenge, a response, and feedback. Aside from having those components the game designers had to incorporate elements that included learning theories such as cognitivism, constructivism, and behaviorism. Other characteristics that influence DGBL included student motivation and self-determination theory (SDT) and flow-type outcomes. There was discussion on how IM incorporates those successful game characteristics such as adaptivity, graceful failure, flow type outcomes, engagement and motivation but there is not enough research to affirm those findings.

It was also useful to review the literature on effective math instruction and how that relates to digital game-based learning. Since students are struggling in math, there is a need to see what constitutes effective math fluency and those ingredients include
automaticity, drill and practice, immediate and corrective feedback, and student motivation. In conclusion, it was essential to view what the literature was on teacher perceptions as those perceptions have an impact on DGBL as well. In the following chapters, I will discuss the methodology of this study, discuss my analysis and conclude with a discussion on further research.
CHAPTER 3

METHOD

The Reyes Elementary school recently adopted the Imagine Math digital math program and has used it for two years. This study questioned students’ math knowledge and teachers’ perceptions along with the challenges of the program. The purpose of this study was to evaluate if Imagine Math affects students’ knowledge. The two research questions were:

1) What is the effect of the Imagine Math program on student’s knowledge?

2) What are teachers' perceptions of using Imagine Math for student learning?

In order to answer these questions, I used an evaluation methods approach, employing both a qualitative and quantitative method for this study. In this chapter, I outlined the research design, setting and participants, innovation, data collection methods, data analysis, rigor and trustworthiness. Tables and figures accompany the appropriate sections.

Research Design

Action research is the process of gathering data, formulating results and then making changes in order to improve upon the situation (Edwards, 2016). Meyer (2000) stated that action research utilizes solutions to solve practical problems and systematically monitors and reflects on the process and outcome. I was interested in how
a digital math program, Imagine Math, used as an intervention, would improve the learning outcomes of students.

Action research is used in educational settings to solve practical problems (Creswell, 2003). This type of research design allows educators to improve upon their craft because it allows the researcher to observe, collect, analyze data and then implement changes. Those changes should improve upon the educational and operational settings and impact student learning (Mills, 2011). With action research, educators are always aiming to improve their craft by studying and refining and putting those findings into action (Creswell, 2003). The combination of action research and an evaluation allows researchers to solve practical problems by using a systematic approach (Ivankova, 2015). It is noteworthy to add that action research depends on the engagement of participants within the research process (Ivankova, Herbey, & Roussel, 2018). And finally, but not limited to, action research allows participants to provide different perspectives throughout the research (Bailey & Gammage, 2019).

In this research, I solved the purpose and answered the research questions by employing the action research design and evaluation approach. The information gathered from this research was used to benefit students and teachers in terms of math learning and the use of Imagine Math. This action research provided a means for the teachers to improve upon their practice of using Imagine Math in their classrooms (Allen & Calhoun, 1998).

Evaluations are useful when combining qualitative and quantitative studies because it provided the viewpoints of the participants, compared and provided value for
both the qualitative and quantitative studies of the combined research, fostered rich conversations about the research area, and provided methodology flexibility (Wisdom & Creswell, 2013). My research topic was best served by an evaluation approach because the quantitative data provided a statistical approach with inquiry and was empirical in design (Creswell, 2003). For the quantitative approach, student data from the pre and posttest was analyzed to support or refute the research questions (Creswell, 2003). Since I was also interested in a holistic approach that involves discovery (Williams, 2007), I employed a qualitative approach. For the qualitative approach, I observed how the teachers perceived the program by conducting a focus group interview. This approach provided me with a more inclusive and in-depth set of data, thus allowing our district to decide about the Imagine Math program.

For this research, teacher learning experiences was the focus. The Imagine Math program is relatively new to the district, and it was beneficial for the district to know how teachers perceived the learning platform. It was interesting to find out what were some initial challenges, how they were remedied, and how teachers reacted when they first started using the program. There were other variables of the teachers’ learning experiences that were explored more in depth. To review, the third grade students were the participants for the quantitative data collection portion and the teachers were the participants for the qualitative data collection portion and both are discussed in detail in the following sections.
Setting and Participants

The setting for this study was Reyes Elementary. Reyes Elementary received its students from the neighboring K-2 primary school. Reyes Elementary was one of two elementary schools within the Reyes School District. The Reyes School District was a publicly funded K-12 district in the Mercey County region in the western United States. The district served a population base of approximately 5,000. The mild climate supported a flourishing agricultural economy of dairy, cotton, rice, sugar beets, tomatoes, and other leading commodities. Reyes School District maintained an enrollment of about 2,300-2,400 students. The district was made up of about 90% unduplicated pupils with 26.7% being English Language Learners and 88.1% being low income (Ed-data.org, 2023). The foster youth count was minimal and ranged from 4-7 students. About 79% of students were Hispanic, 15% were White, 3% were African American, and 3% were other (Ed-data.org, 2023). Approximately 26% of the English Language Learners spoke Spanish with less than 1% speaking Arabic, Punjabi, and other non-English languages (Ed-data.org, 2023).

Student Participants for Quantitative Data Collection

The students at Reyes Elementary used Imagine Math weekly, and its use is described in the Innovation section below. For the school year 2021, 87% of the third-grade students at Reyes Elementary achieved “Standard Nearly Met or Standard Not Met” on the math portion of CAASPP (Ed-data.org, 2023; CAASPP, 2023). This pointed to a lack of performance in the math standards for students at Reyes Elementary, and thus, a digital game based learning tool such as Imagine Math was chosen.
The participants included students in third grade at Reyes Elementary. The total population of third graders at Reyes Elementary was 164 students (Ed-data.org, 2023). For the third graders, about 89% were Hispanic, 9% White, 1% African American and 1% Other. There were 92% of this participant group that qualified for free-and-reduced lunch and 54% were English Learners. For this research study, 117 out of the 164 total third grade students were the sample size \( n = 117 \). The 47 students that did not participate in the diagnostic test fell into these three categories: their parents opted them out from the diagnostic test, they were absent and did not make up the diagnostic test, or they left the district.

The elementary teachers at Reyes Elementary used a variety of teaching strategies to increase student learning. The teacher to student ratio was 1:25 and teachers at Reyes Elementary had been there for an average of 14 years. There was one principal and one counselor who provided administrative support for 25 teachers and the teachers have an average of 13 years teaching, with 4 teachers two years or less (Ed-Data.Org, 2023).

**Focus Group Teacher Participants for Qualitative Data Collection**

The teacher participants were selected via criterion-referenced by grade level and they were all full-time teachers at Reyes Elementary who taught third grade. The participants were notified via email about the focus group interview and the focus group interview questions were attached to the email. The teacher participants all had two years of experience working with IM. A Google Form was sent to collect participants’ demographic information, such as name, preferred pseudonym, years of teaching, ethnicity and gender. All five of the teachers were female and identified as either white or
Hispanic. They ranged in years of teaching from five to 26 with an average of 16.4 years.

Table 3.1 depicts a summary of the teacher-participants.

Table 3.1 Summary of teacher-participants.

<table>
<thead>
<tr>
<th>Preferred Pseudonym</th>
<th>Years of Teaching</th>
<th>Gender</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darlene</td>
<td>6</td>
<td>Female</td>
<td>White</td>
</tr>
<tr>
<td>Liz</td>
<td>21</td>
<td>Female</td>
<td>White</td>
</tr>
<tr>
<td>Nila</td>
<td>24</td>
<td>Female</td>
<td>White</td>
</tr>
<tr>
<td>Rita</td>
<td>26</td>
<td>Female</td>
<td>Hispanic</td>
</tr>
<tr>
<td>Sue</td>
<td>5</td>
<td>Female</td>
<td>Hispanic</td>
</tr>
</tbody>
</table>

**Innovation**

The purpose of this research was to evaluate if IM could improve student math knowledge. The Reyes School District had scored low on recent California State Standards in Math (CA Dashboard, 2023) so the district researched supplemental math programs that worked in surrounding districts. The district did this for two reasons: proximity and similar demographics. After the research, the district chose IM because a few of the surrounding districts had success with it. In the following paragraphs, I will discuss how IM aligns with the literature regarding DGBL first and then explain how IM is used.

From the literature review, IM does have elements that support digital math learning. Those elements include adaptivity, drill and practice, graceful failure, immediate and corrective feedback and motivation and engagement. Adaptivity is incorporated by tailoring student learning to the student’s learning level and adapts lesson pathways that target the student’s needs. For drill and practice, IM allows for students to
repeat similar calculations, practice those calculations until they achieve a certain level of success. The same can be said of graceful failure; IM allows students to fail in the privacy of their student desks and allows students to retry the lesson. IM provides immediate and corrective feedback and shows students how to obtain the correct answer when they fail an attempted lesson and the interactive nature of IM motivates and engages students to plan and earn points to build avatars and collect other prizes. The below table, Table 3.2, summarizes those key points.

Table 3.2 *How IM incorporates DGBL elements.*

<table>
<thead>
<tr>
<th>Elements of DGBL that supports student math learning</th>
<th>How IM incorporates those elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptivity (Andersen, 2012; Plass et al., 2015)</td>
<td>IM tailors student learning to their learning level and adapts lesson pathways that target student needs</td>
</tr>
<tr>
<td>Drill and practice (Berrett &amp; Carter, 2018; Burns et al., 2015)</td>
<td>IM allows students to repeat similar calculations, practice those calculations until they achieve a certain level of success</td>
</tr>
<tr>
<td>Graceful failure (Kapur &amp; Bielaczyc, 2012; Plass et al., 2010)</td>
<td>IM allows students to fail at lesson activities, reteaches the concept and allows students to retry</td>
</tr>
<tr>
<td>Immediate and corrective feedback (Berrett &amp; Carter, 2017; Hawkins et al., 2017)</td>
<td>IM provides immediate feedback and shows students how to obtain the correct answer when they fail an attempted lesson</td>
</tr>
<tr>
<td>Motivation and Engagement (Alsawaier, 2017, Plass et., 2015)</td>
<td>IM is interactive and allows students to play and earn points to build avatars</td>
</tr>
</tbody>
</table>

IM was an established program in the district and teachers used the program for at least 30 minutes every week for the school year. At the beginning of the school year, all students in third grade took the adaptive diagnostic benchmark that provided a prescribed
learning pathway for the student. Once the students were in the prescribed learning pathways, the students logged in weekly, during the 30 minutes, and continued learning activities. Each lesson in the learning pathway allowed students time to learn and practice math.

The students logged into the program through the ClassLink portal and arrived at a landing page. Students then chose whether to complete contests, redeem points, or view messages. Students could also choose to start their current lessons, and these lessons were tailored from the students' diagnostic benchmark that they took at the beginning of the school year. On the main landing page, there was a dashboard that displayed the lessons attempted and certificates earned by the student. On the right of the landing page, the student's cumulative points and contests were available for the student to browse through and choose as well. This is depicted in Figure 3.1 below.

![Figure 3.1 IM landing page](image)
Most of the time the students chose the current lesson as instructed by their teachers and moved on to a lesson. The student then went through the lesson and earned points. The videos in the lessons were interactive and required the student to engage in math tasks, depicted in Figure 3.2 below. If the student answered correctly, the student moved on to another lesson, and if a student answered incorrectly, the student received immediate feedback that helped the student learn the concept. The student was offered another attempt to solve the task and earn points. The lesson start page is depicted in Figure 3.3 below.

Figure 3.2 Sample video in lesson
If a student needed help, there was a help tab that would review the topic with the student. If after using the help tab the student was still having a hard time with the concept, the student could connect with an online tutor. The online tutor was more for home use as the student’s teacher was available for assistance. At the end of each lesson, the student was awarded points and moved on to the next (see Figure 3.4). The IM program used these points to motivate students in their learning, and with these points, students could create avatars for the program (see Figure 3.5). The students were able to view their own mastery from their student dashboard, and from the teacher dashboard, the teacher was able to view the progress of each student in her classroom.
Figure 3.4 Points awarded in IM.

Figure 3.5 Students create their own avatar.

The district and site staff, including teachers and academic coaches, reviewed the diagnostic benchmarks during professional learning community's meetings or their grade
level meetings. There was no requirement to review the data during those carved out times, but it was recommended. Teachers reviewed with their grade level peers and discussed how to improve instruction, but the teachers did not see all the data points and given the size of the district and its funding, little resources were tied to data analysis of the IM program.

**Data Collection**

This study used multiple data sources. The data sources included (a) diagnostic benchmark assessments that was administered to students and (b) a teacher focus group interview. The research questions along with data sources are summarized below in Table 3.3. The following sections provide further detail on how those data sources were collected, what instruments were used in that process, and the procedures for collecting the data.

Table 3.3. *Research questions and data sources.*

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Data Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ1: What is the effect of Imagine Math on students’ knowledge?</td>
<td>Diagnostic Benchmark Assessments</td>
</tr>
<tr>
<td>RQ2: What are teacher perceptions of using Imagine Math for student learning?</td>
<td>Teacher focus group interview</td>
</tr>
</tbody>
</table>

**Diagnostic Benchmark Assessments**

The aim of this study was to measure how well students in grade 3 perform on the Illuminate benchmarks after a semester’s use. At the beginning of the school year, students took the diagnostic benchmark test within the Illuminate Assessment program to determine their initial grade-level math knowledge.
Towards the end of the first semester, students took the same diagnostic benchmark test to see if there was any progress made. The question format for the Illuminate Assessment diagnostic test was a benchmark assessment with the math Common Core State Standards (CCSS). There was a variety of CCSS from the first diagnostic, called pretest in this study, to the second diagnostic, called the posttest in this study; but the ones that will be used to assess if students’ math knowledge increased over that time span are the following: CCSS. Math.Content.3.0A, CCSS.Math.Content.3.NBT, and CCSS.Math.Content.3.MD. These three CCSS are found in both pretest and posttest diagnostic benchmark assessments and shown below in Table 3.4.

Table 3.4 Common Core standards for RQ1.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCSS.Math.Content.3.NBT</td>
<td>CCSS.Math.Content.3.NBT » Grade 3 » Mathematics (2010) » Common Core State Standards » Use place value understanding and properties of operations to perform multi-digit arithmetic</td>
</tr>
</tbody>
</table>
The diagnostic pretest and posttest were given only once each, so there were students who missed taking either the pretest or posttest due to absences. Teachers were asked to have makeup days for those students who missed the pretest and posttest. The pretest and posttest included 24 questions (see Appendix A). The concepts and questions contained California state standards for grade 3 and Common Core state standards (SEG, 2019). The format was multiple choice with four selections. The student selected the choice and submitted or cleared their submission. Students were able to use an online calculator and references to assist them and audio was also available.

Once submitted, the student clicked on “Next” and moved forward. The system took about 1-2 hours to score the diagnostic benchmark, and once done, presented a quantile score to the teacher. Each quantile score determined which standards were met.

**Teacher Focus Group Interview**

In order to get rich and descriptive data for RQ2, data was collected during a teacher focus group interview. The main purpose of this interview was to gather data on the teachers’ perceptions on the use of IM for student learning and provide insight on RQ2. The teachers were scheduled to meet with the researcher for an hour to answer and review their experiences with IM. The teachers consisted of five third grade teachers, who have varied teaching experience with the IM program. The teachers were emailed the interview questions ahead of time so they would be prepared to answer the questions. The findings from this interview were a natural holistic approach that would lend itself to discovery (Creswell, 2003).

The interview was conducted in a teacher’s classroom at the school site. The five teachers all arrived on time and were ready to review their experiences. The eight original
questions, shown in Table 3.5 below, were funneled down to five more open-ended questions. The five more open-ended questions that were used for the interview excluded questions 3, 4 and 7 from the original eight. Though, those questions were omitted, components of those questions were discussed in the five remaining. The purpose was for a more natural dialogue to capture genuine answers. This less structuring of questions would formulate and build new ideas (Leedy & Ormrod, 2001). During the interview, questions were posed to the teacher focus group, and all teachers responded to one or more questions. The teachers were told that the interview would be recorded and used for data collection. After the interview was done, the interview was transcribed and prepared for coding.

According to Krueger and Casey (2000), focus groups promote self-disclosure among participants and this allows the teachers to be more “at ease” in sharing their opinions. This interview was conducted during the afternoon after a Wednesday teacher professional learning community meeting. The length of the interview was approximately 45 minutes. The interview was audio recorded. The question format moved from general to specific, whereby the more specific questions are of greater importance (Krueger & Casey, 2000). Table 3.5 below displays the questions for the focus group interview aligned with the research question.

Table 3.5 Research question 2 for teacher focus group interview.

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Teacher Focus Group Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ2: What are teacher perceptions of using Imagine Math for student learning?</td>
<td>1. What are some success stories that you would like to share about Imagine Math?</td>
</tr>
<tr>
<td></td>
<td>2. What are your thoughts about the Imagine Math program?</td>
</tr>
</tbody>
</table>

44
Research Question | Teacher Focus Group Interview
--- | ---
3. How useful is the Imagine Math program in terms of re-teaching concepts? Why or why not?
4. What are your thoughts on the rewards and engagement part of the program?
5. Is the Imagine Math program easy to use and navigate? Why or why not?
6. You have used the program for about 2 years now, do you feel like it’s making a difference in math instruction? Why or why not?
7. Does the program allow you to focus on a student’s math knowledge so that you can assist her better? Please explain.
8. Is there anything else you would like to add about the Imagine Math program?

Data Analysis

In this research, I used an evaluation approach to collect the data and analyzed both quantitative and qualitative data. My data sources included diagnostic benchmark assessments from the third grade student participants and a teacher focus group interview from the teacher participants. I analyzed Research Question 1 with statistical analysis and Research Question 2 with an inductive analysis approach. For Research Question 1, student diagnostic benchmark assessment results from the pretest were compared to the results for the posttest. This pretest/posttest design was analyzed using a paired samples t-test (Abdullah, Halim, & Zakaria, 2014). Descriptive statistics were also calculated. A reliability analysis was conducted to test the internal consistency of the posttest items. To answer Research Question 2, teacher focus group interview data were analyzed with
codes and identified categories and themes through an inductive analysis approach.

Research questions, data sources, and data analysis methods alignment are shown in Table 3.6. The full description for these analyses is discussed in Chapter 4.

Table 3.6 Research questions, data sources, and data analysis methods.

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Data Sources</th>
<th>Data Analysis Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ1: What is the effect of Imagine Math on students’ knowledge?</td>
<td>Diagnostic benchmark assessments</td>
<td>Paired samples t-tests</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Statistical analysis</td>
</tr>
<tr>
<td>RQ2: What are teacher perceptions of using Imagine Math for student learning?</td>
<td>Teacher focus group interview</td>
<td>Inductive analysis</td>
</tr>
</tbody>
</table>

RIGOR & TRUSTWORTHINESS

This action research was an evaluation approach, and the quantitative validity and reliability were described in the data collection section and are further reported in Chapter 4. For the qualitative data and since I used a focus group interview, I used the following strategies to ensure rigor and trustworthiness of the data and findings: prolonged exposure, thick, rich description, peer debriefing, and audit trail. These strategies are outlined in the following paragraphs.

Prolonged Exposure

The process of prolonged engagement establishes trust between the researcher and the participants (Erlandson et al, 1993; Lincoln & Guba, 1985). I was at the site weekly to check in on the teachers on the use of IM. I introduced the action research to the teachers and asked them to review it with their students. I was the technology director.
for five years at this school district and this school site was one that I visited often and discussed technology with. I was also the main point of contact with Imagine Learning, parent company of IM, and I was very familiar with the IM administrative dashboard.

**Thick, Rich Description**

Lincoln and Guba (1985) and Erlandson (1993) define thick, rich descriptions as descriptions of phenomena in sufficient detail that could be externally validated, whereby the reader can “visualize” the setting, situation, people, or times. Holloway (1997) refers to thick descriptions as detailed accounts of the field experiences about the patterns of cultural and social relationships. I used thick, rich descriptions to describe the qualitative findings with participants’ voices through quotes and examples. I was very familiar with the school site, the staff, and some of the students. This helped me provide details on the setting and the participants involved.

**Peer Debriefing**

I scrutinized my qualitative data with peer debriefing. This allowed my mentor, Dr. Grant, to provide me with valuable input on how I accomplished my research goals. For example, I struggled with how to distinguish my main themes for the qualitative portion, but I listed some possible themes. Dr. Grant posed some questions that guided me in the right direction to be able to come up with those two over-arching themes. Being new to action research, this guidance helped me visualize the themes that impacted the data analysis and eventually discussion portion. I met with Dr. Grant on a weekly basis during the school semesters. For example, for the qualitative inductive analysis portion, Dr. Grant asked what categories stood out for me and that helped me group some
of those categories by descriptive coding. As I furthered in the study, Dr. Grant posed some guiding questions regarding limitations of the study which helped me organize the limitations such as duration of the study and the mediating effect of engagement and motivation.

Shenton (2004) stated that through these frequent debriefings, the researcher can see other alternatives on how to accomplish the research questions; peers might be able to widen the view of the researcher and act as a sounding board. This allowed me to refine my research methods, provided clarity where needed and strengthened my viewpoints (Shenton, 2004).

**Member Checking**

In the duration of this study, I enlisted the perspectives of my teacher participants through class discussions, writing groups and other opportunities. This provided verification of their perspectives that I might have overlooked. For example, when I went to check in with a teacher, she provided some examples of how categories such as teachers’ perceptions of student engagement and independent learning could be nested under student learning and engagement. The more I checked in with the teachers, the more I realized that they had different perspectives on how they used IM and its features which turned into another theme. As stated by Shenton (2004), this allows participants an opportunity to offer suggestions for patterns that they might have observed. The emphasis with this concept is that the participants mean what they say in the interview. Each bit of information from the teacher participants should be represented accurately and within its contextual meaning (Van Maanen, 1998).
Audit Trail

Throughout the research I kept detailed notes of the process and procedures. I noted any interactions with participants including students, teachers and my mentor, Dr. Grant. I detailed the peer debriefing to ensure that I had the proper recommendations, if any. During my peer debriefing with Dr. Grant, I kept detailed notes on how to conduct inductive analysis and where I could possibly find patterns for categories and themes. I did so by referencing the conversation that Dr. Grant and I had and used those notes to help me categorize and group those categories into themes. I also referred to these detailed notes so that I could review the research purpose, design, and questions. This allowed me to trace the course of the research, viewed recommendations and adjusted, if needed (Shenton, 2004).

Procedures

The procedures and timeline for this study are summarized in Table 3.7. There were three phases, and each phase included a participant and a researcher role. The two sample types of participants included students and teachers. As mentioned above, the student participants provided data for the quantitative portion and the teacher participants provided data for the qualitative portion.

Table 3.7 Data collection procedures.

<table>
<thead>
<tr>
<th></th>
<th>Phase I</th>
<th>Phase II</th>
<th>Phase III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timeline</td>
<td>1 month</td>
<td>2-3 months</td>
<td>1 month</td>
</tr>
</tbody>
</table>
Student Participant's Role  Complete consent & assent forms
Take pre-test benchmark diagnostic on Illuminate

Take post-test benchmark on Illuminate

Teacher Participant’s Role  Complete consent & assent forms
Prepare students for pre-test
Administer pre-test

Administer post-test
Focus group interviews

Researcher's Role  Distribute consent & assent forms
Select participants
Observe and assist with testing (pre-test)
Prepare interview questions
Provide research information to parents, school board and community

Observe and assist with testing (post-test)
Observe classes
Administer interviews for the focus group
Gather interview data from focus group
Review interview data results

For Phase I, I submitted my study request to the International Review Board (IRB) and received approval. The IRB approval letter is Appendix B. After that, I received school district permission from the Superintendent and is attached as Appendix C. I reviewed this with teachers and the principal at the site so that they can help me deliver the message to the parents. Then, I distributed consent and assent forms to parents and teachers. I provided an informational item to the school board so that the parents could view it. The school board meetings were streamed live for parents to view. Teachers administered the pretest to their students in third grade in the IM program. This
process took 3-4 weeks. Most of the students tested on the pretest diagnostic day and the students who were absent took the pretest on a make-up day in the following week. I observed and assisted teachers with this. In this phase, I also prepared the interview questions for teachers. As mentioned in the above table, this phase took about 1 month.

During Phase II, students took the posttest on IM and teachers administered it. Like in Phase I, this process took one to two weeks to gather the data. There was one main day for the students to take the posttest and one week for make-up. I observed and assisted with testing and prepared the focus group interview questions.

In Phase III, I collected and gathered data from the focus group interview. I visited the site on a weekly basis to ensure testing went smoothly. The purpose of the visits to the school site was to ensure trustworthiness in the qualitative data collection process. This took place at the school site, and I scheduled with the focus group teachers to meet after school. I transcribed the interview verbatim, and the goal was to capture all third grade teachers’ perceptions. The transcribed interview is attached as Appendix D. This group consisted of teachers who have mixed feelings about IM. This process took one to two weeks for a total of two to three months.

After that, I analyzed the data and documented the findings. After I analyzed the data, I shared it with the teachers, site and district administration, parents and community. The data analysis started with the quantitative results first and then I compiled the transcriptions from the qualitative portion; which was the focus group interview.
CHAPTER 4

DATA ANALYSIS AND FINDINGS

The purpose of this study was to determine if Imagine Math affected students’ knowledge. The two research questions for this study were: 1) What is the effect of Imagine Math on students’ knowledge? and 2) What are teacher perceptions of using Imagine Math for student learning? In the following sections, the quantitative data will be described first followed by the qualitative.

Quantitative Data Analysis and Findings

Diagnostic Benchmark Assessment

The Illuminate benchmark assessment instrument is a diagnostic benchmark assessment administered to students in the Fall and Winter. Data from the Illuminate benchmark assessment \( n = 117 \) for the pre- and posttest were subjected to statistical analysis. The Fall student results were totaled as the pretest and the winter student results were totaled as the posttest. The data included pre- and posttest results for three standards: CCSS.Math.Content.3. Numbers and Operations in Base Ten (NBT), CCSS.Math.Content.3. Measurement and Data (MD), and CCSS.Math.Content.3. Orders and Algebraic Thinking (OA). There was a total of 22 items and only 19 of them count
towards the three standards NBT, MD, and OA. The other three items, questions 20-22 are to test student knowledge in upcoming standards. Of the pertinent 19 items, some questions addressed more than one standard. There was a total of six items for CCSS.Math.Content.3.NBT, six items for CCSS.Math.Content.3.MD, and 12 items for CCSS.Math.Content.3.OA. Table 4.1 represents the standards associated with the items, and Table 4.2 depicts the total number of items per standard. The maximum number of points possible scored was 24. Some of the items included more than one standard. For example, Item11 addressed all three standards, so when scored, this item counted for each standard. A copy of the Illuminate benchmark assessment is available in Appendix A.

Table 4.1 Item and standard alignment for Illuminate benchmark assessment

<table>
<thead>
<tr>
<th>Item</th>
<th>Standard</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CCSS.Math.Content.3.OA</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CCSS.Math.Content.3.OA</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CCSS.Math.Content.3.OA, CCSS.Math.Content.3.NBT</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CCSS.Math.Content.3.OA</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>CCSS.Math.Content.3.OA</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>CCSS.Math.Content.3.OA</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>CCSS.Math.Content.3.OA</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>CCSS.Math.Content.3.OA</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>CCSS.Math.Content.3.NBT</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>CCSS.Math.Content.3.NBT</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>CCSS.Math.Content.3.OA, CCSS.Math.Content.3.MD, CCSS.Math.Content.3.NBT</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>CCSS.Math.Content.3.OA, CCSS.Math.Content.3.NBT</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>CCSS.Math.Content.3.MD</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>CCSS.Math.Content.3.OA, CCSS.Math.Content.3.MD</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>CCSS.Math.Content.3.OA</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>CCSS.Math.Content.3.MD</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>CCSS.Math.Content.3.MD</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>CCSS.Math.Content.3.MD</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>CCSS.Math.Content.3.NBT</td>
<td></td>
</tr>
</tbody>
</table>

**Table 4.2 Number of items per standard**

<table>
<thead>
<tr>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCSS.Math.Content.3.NBT (Number and Base Tens)</td>
</tr>
<tr>
<td>CCSS.Math.Content.3.MD (Measurement and Data)</td>
</tr>
<tr>
<td>CCSS.Math.Content.3.OA (Operations and Algebraic Thinking)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

Standard CCSS.Math.Content.3.NBT (Standard NBT) was the standard that assessed a student’s knowledge of numbers and operations in base ten. Students, if
proficient, should be able to use place-value understanding and properties of operations to perform multi-digit arithmetic (CA Dept. of Ed, 2015). Standard CCSS.Math.Content.3.MD (Standard MD) included measurement and data. Students in third grade were assessed for measurement and estimation of intervals of time, liquid volumes, and masses of objects. Other clusters in this standard included assessing for students’ knowledge of geometric measurement, representation and interpretation of data and reasoning with shapes and their attributes (Ca State Dept. of Ed, 2015). The standard CCSS.Math.Content.3.OA (Standard OA) assessed students’ math knowledge of operations and algebraic thinking for third grade. The major clusters included problem solving with multiplication and division, understanding multiplication and the relationship between multiplication and division, being able to multiple and divide within 100 and solving problems with the four operations and being able to identify and explain patterns in arithmetic (Ca State Dept. of Ed, 2015).

The quantitative findings present first the overall results, and then the findings are separated by standard. The internal reliability was tested using the posttest data and provided a Kuder-Richardson 20 (KR-20) of 0.87, which defined the instrument as adequately reliable. Because four tests were run using the same data, a Bonferroni adjustment was made to the $\alpha$ significance level to .0125 ($\alpha = .05/4 = .0125$).

**Descriptive statistics.** The descriptive statistics overall provided the following for the pretest results ($M = 8.40, Mdn = 7.00, SD = 4.25$) and posttest results ($M = 13.10, Mdn = 14.00, SD = 6.24$). Standard NBT provided pretest results ($M = 2.21, Mdn = 2.00, SD = 1.61$) and posttest results ($M = 3.56, Mdn = 4.00, SD = 1.57$). Standard MD gave pretest results ($M = 2.10, Mdn = 2.00, SD = 1.56$) and posttest results ($M = 2.29, Mdn = 2.00, SD = 1.56$).
For Standard OA pretest results ($M = 4.11$, $Mdn = 3.00$, $SD = 2.11$) and posttest results ($M = 7.22$, $Mdn = 8.00$, $SD = 3.69$) were obtained. The following table, Table 4.3, illustrates the descriptive results.

Table 4.3 *Descriptive statistics for pre- and posttest (n = 117)*

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
<th></th>
<th>Posttest</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$Mdn$</td>
<td>$SD$</td>
<td>$M$</td>
</tr>
<tr>
<td>Overall</td>
<td>8.40</td>
<td>7.00</td>
<td>4.25</td>
<td>13.10</td>
</tr>
<tr>
<td>CCSS.Math.Content.3.NBT</td>
<td>2.21</td>
<td>2.00</td>
<td>1.61</td>
<td>3.56</td>
</tr>
<tr>
<td>CCSS.Math.Content.3.MD</td>
<td>2.10</td>
<td>2.00</td>
<td>1.56</td>
<td>2.29</td>
</tr>
<tr>
<td>CCSS.Math.Content.3.OA</td>
<td>4.11</td>
<td>3.00</td>
<td>2.11</td>
<td>7.22</td>
</tr>
</tbody>
</table>

**Inferential statistics.** For the overall Illuminate benchmark assessment for all three math standards, a paired samples $t$-test was planned to compare the pretest and posttest means. A Shapiro-Wilk test was used to confirm normality of data ($p = .059$). A paired samples $t$-test comparing pretest means ($M = 8.40$, $SD = 4.25$) to posttest means ($M = 13.10$, $SD = 6.24$) reported $t(117) = -11.69$, $p < .001$, Cohen’s $d = 1.08$. Therefore, posttest means were significantly higher than pretest means, and students significantly improved from pretest to posttest. In addition, Cohen’s $d$ indicated a large effect size (Aarts et al., 2014).

Paired samples $t$-tests were planned to compare pretest and posttest means for each of the three standards. The results for the individual standards indicated a significant deviation from normality with a $p < .001$ for the Shapiro-Wilk test for Standard OA and Standard NBT; hence, the non-parametric Wilcoxon-Signed rank tests were conducted.
For Standard OA, the pretest scores ($Mdn = 3.00$, $SD = 2.11$) were significantly higher from the posttest scores ($Mdn = 8.00$, $SD = 3.69$) with $W = 315.00$, $z = -8.06$, $p < .001$; so, students' mathematics knowledge improved on this standard. For Standard NBT, the pretest scores ($Mdn = 2.00$, $SD = 1.61$) were significantly different from posttest scores ($Mdn = 14.00$, $SD = 6.24$) with $W = 112.00$, $z = -7.23$, $p < .001$; so, students' mathematic knowledge improved on this standard. For Standard MD, the pretest scores ($Mdn = 2.00$, $SD = 1.56$) were not significantly different from the posttest scores ($Mdn = 2.00$, $SD = 1.73$) with $W = 1587.50$, $z = -1.38$, $p = .153$; so, students did not significantly improve on this standard. The following table, Table 4.4, summarizes these findings.

Table 4.4 Non-parametric Wilcoxon-Signed rank test statistics.

<table>
<thead>
<tr>
<th>Standard</th>
<th>$W$</th>
<th>$z$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCSS.Math.Content.3.NBT</td>
<td>112.00</td>
<td>-7.23</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>CCSS.Math.Content.3.MD</td>
<td>1587.50</td>
<td>-1.38</td>
<td>.153</td>
</tr>
<tr>
<td>CCSS.Math.Content.3.OA</td>
<td>315.00</td>
<td>-8.06</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Qualitative Data Analysis and Findings

Data Analysis

Qualitative data were collected through a focus group interview with five third grade teachers. The interview lasted approximately 45 minutes and generated 84 initial codes as part analysis. Coding is one way to analyze data (Saldana, 2016). Coding is a research approach that requires inductive analysis. The coding, which used inductive analysis, was broken into two main steps: first and second cycle. The first cycle coding
included descriptive coding and open coding, digitally, and the second cycle coding included a manual and digital process which was performed by map coding. Inductive analysis will be described first and then the following paragraphs will detail those two cycles of coding.

Inductive analysis is a research approach that involves identifying patterns, themes, and categories in data in order to develop theories and understandings. According to Saldana (2016), inductive analysis involves starting with empirical observations and then generating theories from those observations. Saldana (2016) also notes that inductive analysis is particularly useful in exploratory research, as it allows researchers to identify unexpected or previously unknown patterns in the data. Saldana (2016) emphasizes that inductive analysis requires an open and flexible approach, as researchers must be willing to revise their theories and categories as they analyze the data. Overall, inductive analysis is a valuable approach for generating new insights and theories from data, and it requires careful attention to the patterns and themes that emerge from close analysis.

**First Cycle Descriptive Coding.** I entered my teacher focus group interview transcript into DelveTools and followed the descriptive coding method for the first cycle (Saldana, 2016). Every time a teacher provided a response to an interview, I entered a descriptive code and tagged that segment of data with the code. I used descriptive codes such as “only supplement,” “like using IM,” and “at student learning level.” An example is shown in Figure 4.1 below.
The responses were gathered and transferred into codes and are supposed to represent and capture a datum’s primary content (Saldana, 2016). As the coding continued, certain patterns arose, such as how teachers perceived students’ attitudes on IM. In Figure 4.2., teachers perceived that students were engaged and excited about the activities and games in IM. Teachers also commented on how the students “get to see how they do compared to their classmates,” which turned into a code. These teacher comments became descriptive codes for this first cycle.
Certain patterns included grouping codes into the same code. Such as, “whatever incentives are built in” and “loved building their avatar” fell into a group, which was coded as “incentives built into program.” Other repetitive patterns emerged such as “IM does not have reports on student progress” and “IM does not update in real time” fell into the same code of “IM does not have reports on student progress.” Other codes fell into this larger code group, “IM does not have reports on student progress,” and these codes included “student results updated the next day” and “lessons passed report takes a while to get”. For these repetitive codes, I combined them into larger categories. In this first
cycle process, I collected 84 codes and prepped them for the second cycle for categorizing (Saldana, 2016).

**Second Cycle Code Mapping.** The codes were printed and prepared for the second cycle process. The codes were cut and arranged into two broad groups on a table for the process of code mapping (Saldana, 2016). Code mapping is the process of mapping codes through several iterations of analysis to form categories and condensed more to form themes (Saldana, 2016). This code mapping approach utilized both a digital and manual component. The digital component included using Delve to categorize and group subcodes into codes, and the manual component was to cut up the codes and organize them into categories and eventually, themes. Figure 4.3 is an example of the digital component. The two subcodes “Like using IM” and “don’t need teacher support” were grouped into the larger code “IM is good for independent learning”. The purpose of this organization was to find similarities and patterns in the teachers’ responses (Saldana, 2016).
After the digital component, the codes were then cut and organized and re-organized to fit into categories for the manual component. There were patterns in the teachers’ responses, which were turned into codes, and then grouped into categories (Saldana, 2016). This process was repeated for all the categories and certain themes arose from this manual grouping. An example of this for the manual approach was with the following codes: “IM is not user friendly for teachers,” “teachers struggling with IM navigation,” “difficult to manage IM,” and “learning new software” were placed into the “not teacher friendly” category. Figure 4.4 depicts this example.
Once the categories were condensed and finalized, the digital approach was used to match the analog approach into the Delve tool. Figure 4.5 depicts an example of replicating the analog groupings into the Delve tool digitally. This process resulted in the identification of five categories.
As analysis progressed, there was a shift from data segments into more abstract, general thematic concepts (Saldana, 2016). During this process, peer debriefing and analysis of the categories and themes occurred weekly. For example, from the first cycle, descriptive coding gave rise to familiar categories and I was asked if those categories could fit into broader categories such as teacher perceptions about the use of IM or teacher perceptions about using IM for independent learning. From these categories and with peer debriefing, five categories were identified, and two themes emerged. Those two themes were: (1) Teachers valued IM for student learning because of student engagement and independent learning but are unsure of its impact on mathematics learning and (2) Teachers held differing views about how they used IM and its features. A diagram that illustrates this concept is below (see Figure 4.6).
Figure 4.6. *Categories into themes diagram.*

**Themes and Interpretations**

In the following sections, the themes and subcategories will be described. These themes were defined from the analysis of the teachers’ experiences and perspectives. Wherever appropriate the themes will be tied to the literature reviewed from Chapter 2 (Xu & Zammit, 2020). The themes along with categories and examples are summarized in Table 4.5.

Table 4.5 *Summary of Themes*

<table>
<thead>
<tr>
<th>Themes</th>
<th>Categories</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Teachers valued IM for student learning because</td>
<td>a.) Teachers’ perceptions of student engagement with IM.</td>
<td>Rewards</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Theme One: Teachers Valued IM for Student Learning Because of Student Engagement and Independent Learning but Were Unsure of Its Impact on Mathematics Learning

The third-grade teachers in this study perceived IM as engaging for students and good for independent learning. IM was supplemental to their mathematics instruction, and IM supported students who were below grade level. For the teachers, IM was an intervention to improve students’ mathematics learning. Teachers expressed that engagement with IM and student motivation toward IM led students to be able to work
independently. In contrast, however, the teachers expressed they could not conclude if IM had any impact on mathematics learning.

In terms of DGBL, studies suggested that teachers perceive DGBL to engage students in learning and fostering real-world skills (Gee, 2005; Shaffer et al, 2005; Van Eck, 2015). Other studies suggested that teachers perceived digital games were useful for short-term learning forms such as drill-and-practice, trivia, and puzzle games (An, 2017). Teachers have also perceived that the rewarding nature of DGBL helped students in motivation and engagement with learning (Gaudelli & Taylor, 2011; Schrader et al, 2006). Teachers' perceptions for this theme were supported by three categories: a) teachers’ perceptions of student engagement with IM, b) teachers’ perceptions about independent learning in IM, and c) teachers cannot tell if IM has impacted math learning.

**Teachers’ Perceptions of Student Engagement with IM.** Student engagement for the third grade teachers meant that students were deeply involved in mathematics learning. Students were on task and were able to complete those tasks, moving from level to level in IM. The teachers expressed that IM had built-in incentives engaging the students in learning math. Engagement has required the voluntary use of high functioning learning strategies to foster cognitive development (Turner, 1995; Plass et al., 2015). Other research has suggested that as students became engaged in a task, students became deeply involved (Csikzentmihalyi, 1997). As students become deeply immersed in DGBL, such as IM, students’ motivations have led to successful learning experiences (Davis & McPartland, 2012).
The teachers appreciated components of IM that engaged their students. These components included built-in incentives, such as building avatars and enjoyable activities. Teachers commented that the intrinsic rewards system of IM engaged students. Four of the five teachers interviewed expressed positive comments about student engagement when using IM. For example, Liz said, students “loved building their avatar” and “They get to dress them [avatars] in different outfits.” Teachers were upbeat about this topic and said student excitement led to engagement with IM for mathematics learning. Student excitement with DGBL tools has supported student learning (Plass et al., 2015).

**Teachers’ Perceptions about Independent Learning with IM.** Independent learning for the third grade teachers meant that students were working with little to no assistance when using the IM program. Teachers judged independent learning for IM as students working quietly through the activities. Teachers also viewed independent learning in IM as students working on their own mastery content with students at varying learning levels. Recent studies showed that teachers used DGBL for the short-form genres (An, 2017), such as trivia and puzzles, and less for immersive learning games (Takeuchi & Vaala, 2014). The teachers’ perceptions in this recent study performed by Takeuchi and Vaala (2014) contrasted with how DGBL experts believed—in that the true power of digital games lied in their ability to provide students with situated learning experiences (Gee, 2005; Shaffer et al, 2005; Van Eck, 2015). IM incorporates both a short-form genre such as drill and practice, whereby the students solve mathematical problems; and an immersive learning component whereby the students must solve mathematical problems.
and add more features to the student’s avatar to go from level to level in the overall journey.

As the student’s avatar proceeded through this journey, different situations arose for the student to resolve. This means that the more students were in situational, simulation digital games, the more learning opportunities happened. This allows for cognitive absorption where students can learn independently (Csikszentmihalyi, 1990). This means that students can learn simultaneously while they are engaged in using IM to learn. Regarding independent learning, most of the teachers expressed similar comments to Csikszentmihalyi (1990), Gee (2005), Shaffer et al (2005), and Van Eck (2015). They said:

Rita: Independently that they don’t need us to be able to do the program.

Nila: They can go to Imagine and work on it, and I like it because it is at their level.

Similarly, Sue and Liz spoke about the value of using IM for independent work. They said:

Sue: [IM was good for] going out on isolation [distance learning].

Liz: At home this is what you would do.

From these comments, the teachers perceived that the students were actively engaged in independent learning with IM, and the students could use IM independently.

*Teachers Were Not Sure of IM’s Impact on Learning*
In order to know if IM had any positive impact on students’ learning, teachers needed to observe mathematics content knowledge growth from classroom assessments. The teachers were frustrated because they were unable to determine if IM had any positive impact on their students’ mathematics knowledge. Studies have suggested that there have been a variety of methods used to measure the effectiveness of DGBL (All et al., 2014), such as O’Neil, Wainess, Baker (2005) and Berrett and Carter (2017). Furthermore, these methods were quasi-experimental and reported inconclusive results (All et al., 2014).

The teachers could not attribute any growth in mathematics knowledge because of IM, and they ascribed this difficulty to the reporting features in IM. All five teachers agreed they could not verify if IM had had any impact on improving their students’ mathematical knowledge. During the focus group interview, I asked, “Do you think IM had any impact on math knowledge?” They responded:

Liz: I, I wouldn’t...yeah.

Rita: I can’t tell that. Can you guys?

Nila: I can’t tell.

Sue: Me either.

While the teacher-participants were frustrated by this problem, they expressed the cause of the conundrum was attributable to IM’s system. With a lot of passion and frustration, Nila stated, “It would be nice to able to just know where to go to get the reports to see where they’re [the students are] at.” The teachers expressed their discontent with not being able to access students’ progress reports in IM. They said, if they could get
to the student reports, they would then be able to do more focused teaching on areas identified as deficiencies by IM. The teachers expressed that they would be able to go back and fill in the gaps. However, without the reports, the teachers could not confirm how the students were progressing, any student deficiencies, and address any problem skills. IM’s reporting features and other variables such as other teacher instruction, grade-level math programs gave teachers the perception that it was hard to tell if IM was responsible for growth in their students’ math knowledge.

**Theme Two: Teachers Held Differing Views about How They Used IM and About Its Features**

The third-grade teachers interviewed held different perspectives about how they used IM and its features. The school district required IM to be used for instruction 30 minutes per week. Without further guidance or expectations for grade levels or curricular integration, the teachers independently selected how and when to use IM. Teachers expressed that the inconsistent class-by-class, or teacher-by-teacher, use of IM on a weekly basis meant that their grade level was unfocused in terms of the expectations. In addition, teacher perceptions of IM’s features impacted its use in classrooms. Some teachers perceived that IM was user-friendly, and others mentioned that it lacked many user-friendly features.

Teacher perceptions influence teaching practices (Gaudelli & Taylor, 2011), and this was also true with how the teachers in this study used IM and its features. In terms of DGBL, teachers believe that digital games are effective in teaching real-world skills to students (An, 2017). Most teachers use digital games for shorter-form genres such as
drill-and-practice, trivia, and puzzle games (An, 2017) and few teachers use them for simulation and more immersive learning games (Takeuchi & Vaala, 2014). Two categories that supported this theme are: a) teachers’ perceptions about the use of IM and b) teachers’ perceptions about the features of IM.

Teachers’ Perceptions about the Use of IM. Teachers shared their perceptions about using IM through success stories, discussing how user-friendly or un-user-friendly IM was, and the inconsistent use of IM. The teachers’ experiences with IM affected how it was used within each teacher’s classroom. Some teachers’ positive experiences with IM encouraged its use in their classrooms. Both positive and negative comments about the user-friendliness of IM also impacted its use. Moreover, the teachers mentioned that even though the feeder school used IM and given the district expectation for the use of IM, teachers still saw inconsistent use within their grade level.

One of the focus group interview questions was if teachers had any success stories to share about the use of IM. The teachers shared that due to the gameplay in IM, students were motivated to use IM. For example, Nila said, “students are excited” every time they use IM. Similarly, Rita explained that students enjoyed the competition aspects of IM. She said, “They [students] like seeing how they compare to kids in the classroom.” Another teacher, Rita, mentioned that IM was “good for small group work” because it supported differing ability levels. The students’ motivation toward IM, the teachers explained, encouraged its use.

User-friendliness encompassed multiple points of view; it included how easy IM was for teachers and students to use and whether the system features of IM were easy to
use. In terms of user-friendliness when it comes to the use of IM, there were mixed feelings. On the positive side, a few of the teachers' mentioned IM was easy for students to use and that they like “the friendliness ... for the kids.” Rita mentioned she liked how easily she could integrate IM during downtime or open times during her instructional day. She said, “I love that I’m able to just plug it in and then use it throughout the day.” This was more to the user-friendliness for the students and how that enables teachers to teach and assist along the way.

The teachers also expressed difficulties using IM. A few of the teachers mentioned that the navigation, and especially the reporting features, were challenging thus making IM not teacher friendly. For example, Nila stated, “It’s not teacher friendly.” Rita agreed, stating, “It’s difficult to manage on the teacher’s side. It’s not teacher friendly.” Some of those lacking features included real-time progress monitoring and reports, which the teachers mentioned were instrumental in teaching and intervention. Most of the comments surrounding teacher friendliness were about how IM did not update in real time, which prevented real time student monitoring by teachers, creating reporting and monitoring challenges for the teachers. Perceptions about the reporting, the teachers explained, related directly to the cumbersome nature of IM’s navigation.

The last group of teacher perceptions about the use of IM dealt with the inconsistent use of IM. As explained earlier, the teachers mentioned that even though the teachers were aware of the district expectations for using IM, there was “a lack of consistency” (Darlene, Focus Group) among the third grade teachers’ implementations. Sue posited that, “I don’t think I use it [IM] enough in the classroom to, like, even [to] determine if it’s going to be effective.” Darlene explained that due to the different
implementations, the teachers could not compare their classes. She stated, “Like some of
us might use it more than others, so then we can’t compare like our classes to see what
like, you know.” as she was referring to how inconsistent use of IM makes it more
challenging to compare student progress. She lamented that there was even a lack of
consistency within her own classroom. Darlene stated, “Like at least 15 minutes, but then
um, I know some students don’t get to it.” This inconsistency across the grade level led
some teachers to use it more than others, and those that used it more often mentioned that
IM was user-friendly.

**Teachers’ Perceptions about the Features of IM.** Another noted pattern was teachers’
perceptions about the features of IM. The teachers perceived the features of IM being the
navigation of the dashboard, pulling reports of student and class progress and ease of use
of those features. Other teacher perceptions about the features of IM included online
assistance and instant support for teachers and students. These teacher perceptions about
features addressed the user-friendliness of IM. According to the research, studies on
teacher perceptions and DGBL are inconclusive because of the quasi-experimental nature
and there exist little to no literature about the features of digital games and their use. (All
et. al, 2014; O’Neil et al., 2005). These studies point to the need for more common
baseline comparisons such as the use of features of digital games. The subcategories that
were grouped into this category were useful reports in IM, IM does not have certain
reports that are essential, and how these features were not conducive to reteaching.

One feature of IM two teachers found useful was a specific type of reporting. Rita
and Darlene mentioned that IM had a good report for Student Study Teams (SSTs) and
the intervention needed for these students. Rita commented, “I do like their — there is a
report that I use for, especially for SSTs.” Darlene agreed identifying the specific interventions for this population of students was essential. She said, “You know intervention, these are the kids that need it.” A SST is a partnership between the school and home that focuses on an individual plan to help a student become more successful in school (UnderstandingSpecialEducation.com, 2022). IM is useful to the teachers because a progress report in IM can identify where the student needs more assistance with the student’s math learning. From there, the teacher can target those areas where the student needs more assistance. The teachers agreed that real-time progress reports would be beneficial to math learning in IM.

The teachers expressed many concerns about how IM did not produce essential reports, such as student progress reports and class progress reports. As explained in Theme Two above, the lack of reporting and access to reporting, the teachers explained, made IM difficult to leverage for remediation. For example, Nila mentioned that reports identifying a student’s achieved mathematical skills and weak skills “would be useful for a parent conference.” In terms of student progress reports, Nila wished, “It would be nice to be able to just know where to go to get the reports to see where they’re [students are] at and what they’re doing.” Rita agreed that student progress reports from IM would be valuable parent communications. Rita said, “To show parents at conferences, you know, to where they’re — You know look at their own kid at kindergarten level and they should be doing third grade level stuff.” Nila also agreed. She stated, “Yeah, it’d be nice to just see the visual, you know, where they’re [students are] at individually …. But it only lists a couple of kids at a time, and I can’t really see the bigger picture.” It is worth noting that IM does produce reports, just not individualized real-time reports that show student
progress. The teachers perceived that real time monitoring and progress reports were essential to reteaching and assisting students with math fluency.

Nila made an important connection between the features of IM to its user-friendliness, as described in the previous category. She reminded the group that if “we can’t look up the scores, if we can’t, it’s not teacher friendly. Then how can we reteach?” The limited features in student reporting in IM, she explained, affected its usefulness, which affected her effectiveness as a teacher to support her students. As mentioned earlier in the above paragraph, a report on student progress would be beneficial to parent conferences and promote re-teaching efforts. Like the SST situation mentioned above, if the teachers know where the student’s area of focus is, the teachers feel that they would be able to reteach those concepts.

**Chapter Summary**

In this chapter, quantitative and qualitative data were analyzed and reported. For quantitative data, a diagnostic benchmark assessment was used to measure mathematics content knowledge. This assessment included the same pretest and posttest items and standards associated with them. These data were analyzed using a paired $t$-test. In the results, students ($n = 117$) improved significantly from pretest to posttest. In terms of the individual standards, students improved significantly on standards OA and NBT; whereas students did not improve significantly on standard MD.

A teacher focus group interview was used to collect qualitative data about the implementation of IM, and the qualitative data of the study were analyzed. Overall, two themes with subcategories were identified. The teachers valued IM for student learning
and perceived IM as an engaging digital learning platform that had user-friendly support for the students and provided ample independent learning opportunities for the students. In contrast, however, the teachers perceived IM as lacking certain essential reports that could be used for parent conferences and reteaching; though IM did have a good report for SSTs. And lastly, teachers were not sure about IM’s impact on students’ mathematics learning.
CHAPTER 5

DISCUSSION, IMPLICATIONS, AND LIMITATIONS

In this chapter, there will be a discussion on the findings of the study, what implications are for the students, school and school district and what the limitations of the study were. The discussion will connect the study to research questions and literature. The implications section will connect the findings in this chapter to the implications for the researcher, the grade-level, school and district, and more broadly to the future study of DGBL.

Discussion

The following discussion sections are organized by the research questions: (1) What is the effect of Imagine Math on students’ knowledge and (2) What are teachers’ perceptions about Imagine Math?

RQ 1: What is the Effect of Imagine Math on Students’ Knowledge?

Digital games, like IM, have been shown in many studies to modestly improve students’ knowledge and skills (e.g., Berrett & Carter, 2017; Burns et al, 2012; Rave & Golightly, 2014) and in mathematics specifically (Byun & Joung, 2018; DeLeon, 2020; Hussein et al., 2022). Effective elementary math fluency depends on a series of steps that include the four math operations of multiplication, addition, subtraction, and division (Musti-Rao et al, 2015; Nelson et al, 2016). This development of math fluency depends
on the repetition and quick access to those four math operations (Baroody, 2006). In California’s third grade CCSS math standards, those four operations are found in three standards: NBT, MD, and OA (Ca Dept. of Ed, 2022). The more fluent a student is with these operations, the more effective the student can cognitively use this information for math calculation (Hechinger, 2018). The following sections will include discussions on the findings from the study divided into two sections: a) use of DGBL showed increases on students’ math knowledge and b) motivation and engagement promoted students’ math learning.

**Use of DGBL Showed Increases on Students’ Math Knowledge.** In Hussein et al.’s (2022) systematic review of DGBL, 81% of the studies reported positive learning gains for mathematics. Additionally, in Byun and Joung’s (2018) meta-analysis of DGBL, 17 studies reported improved mathematics learning with an overall moderate effect size. The current findings can be added to the lists of studies reporting positive gains. In this study, the students showed significant mathematics learning improvements in two California third grade standards, NBT (Pretest $M = 2.21$; Posttest $M = 3.56$) and OA (Pretest $M = 4.11$; Posttest $M = 7.22$). Students who were fluent in standard NBT would have been able to perform arithmetic operations in base ten, and students who were fluent with standard OA would have been able to perform problem solving skills with multiplication, division, subtraction, and addition (CA Dept. of Ed., 2022). Berrett and Carter (2017) would argue that this increase in math fluency is due to drill and practice, and immediate and corrective feedback.

In this study, the students were tested during the Fall and Winter, so the students had three months to acquire this new math knowledge. According to the literature for
effective math fluency, drill and practice is directly related to a reduction in working memory and cognitive loads (Fuchs et al., 2005). Berrett and Carter (2017) contended that the more opportunities students have to practice math fluency, repetitively, the quicker it is for them to acquire newer learning. Given the district expectations of using IM for at least 30 minutes a week, the students had sufficient opportunity to experience drill and practice with the math concepts. In the IM program, students were given numerous chances to try the problems that incorporated those standards. For example, standard NBT, students would be shown graphics with numbers of items such as pennies or strawberries, and the students would have to click on the correct count. This process would repeat itself until students mastered the concept with at least 80% or higher. As stated by the report from NMAP (2008), it is important that students be exposed to sufficient opportunities with regular intervals for math fluency.

Immediate and corrective feedback is an essential part of building math fluency (Berrett & Carter, 2017; Fuchs et al, 2008; Hawkins et al, 2017; NMAP, 2008). Immediate feedback after students have attempted a math problem has been essential to increasing a student’s math knowledge, and this feedback must provide the correct answer as well, so students do not assume they provided the correct answer (Hawkins et al, 2017). In this study, students received immediate and corrective feedback through IM whether students answered correctly or incorrectly. This constant feedback might have encouraged students to do better on subsequent problems (Berrett & Carter, 2017).

**Motivation and Engagement Promoted Students’ Math Learning.** While motivation and engagement were not variables specifically measured in this study, the qualitative findings spoke to teachers’ perceptions that their students were engaged with
IM, and they were motivated to use IM. Liz and Nila mentioned that their students “loved building their avatars” and “dress[ed] them [avatars] in different outfits,” respectively, when using IM in their classrooms. Digital games have been found to increase learning when motivation also increased (Behnamnia et al., 2022). Snyder (2016) stated that students perceived IM to be fun and exciting. In terms of the present study, Rita contended that the students liked playing IM and that IM had to be turned off or used as a reward due to students’ engagement with the digital game.

**RQ 2: What Are Teachers' Perceptions of Using Imagine Math for Student Learning?**

The study of teachers’ perceptions about the integration of DGBL has been relatively small (Hsu & Chiou, 2011; Li & Huang, 2016) but has been growing recently (cf. Peddycord-Liu, 2019; Yeo et al., 2022). Of the available research, teachers’ perceptions about DGBL focused mainly on demographics such as gender, years of experience, career stages, and age (Baek, 2008; Joyce et al., 2009; Hsu et al., 2017; Koh et al., 2012). In this study, all teachers that participated in the interview were female, had an average of 16.4 years of teaching, and identified as either White or Hispanic. While demographics were not a focus of this study, the teacher participants shared similar views when it came to their perceptions about the use of IM for student learning. From this study, teacher perceptions will be discussed through three categories: (a) teachers’ perceptions influenced their teaching practices, (b) teachers liked tools that were easy to use, and (c) teachers used tools that supported student learning. Even though the three categories are separated for discussion, the categories do relate to one another and will be discussed in further detail in the following paragraphs.
**Teachers’ Perceptions Influenced Their Teaching Practices.** Teachers’ perceptions do influence teaching practices (Gaudelli & Taylor, 2011). Teachers’ teaching behaviors are influenced by their beliefs, and this extends into their perceptions about the use of DGBL (An, 2017; Bourgonjon, De Grove, De Smet & Van Looy, 2013; Ertmer, 2005). The integration and effectiveness of DGBL have been directly attributed to teachers’ acceptance (Bourgonjon et al., 2013). In this study, the teachers perceived IM as an intervention to improve students’ math learning, and the teachers liked that students could use IM for different learning ability levels, especially the students who were below grade level. One teacher, Rita, commented “It’s at their learning level,” and there was no other supplemental resource available for students who were behind. This perception that IM was the only supplemental for students below grade level, coupled with district expectations, influenced the teachers’ practice. The teachers used IM for independent learning, such as homework in the afterschool program and at home (i.e., Liz), and as a reward when students were done with classwork. Teachers’ perceptions about DGBL in this study ultimately influenced how they integrated digital games into their daily lessons.

Successful digital games have been good for learning and have included shared characteristics (Groff et al. 2010; Gros, 2007; Proulx et al. 2017; Ritzko & Robinson, 2006). Those shared characteristics of successful digital games have included motivation, engagement, adaptivity, and graceful failure (Plass et al. 2015). IM has incorporated these successful DGBL characteristics (Snyder, 2016), and the more successful the DGBL, the more the digital game can influence a teacher’s perception (An, 2017). In this study, the teachers shared success stories regarding those successful
characteristics such as student engagement, rewards, and differentiated instruction. The teachers’ perceptions regarding student engagement were their students liked using IM and the rewards features engaged students in learning. This finding corroborated Kokandy’s (2021) research, where teachers reported engagement was a primary reason for integrating digital games. Teachers commented that students liked building their own avatars and dressing their avatars. For example, one teacher reported that engagement led students to be able to do “small group work” (Rita) and supported students working at their own ability levels. This finding was also supported by Snyder (2016) and Berrett and Carter (2017), who reported IM allowed students to learn independently at their own pace. Successful digital games’ characteristics such as engagement and rewards afford independent learning, which has directly influenced teacher perceptions about using DGBL such as IM.

Teachers, regardless of their demographics, have perceived technical factors as having an impact on their teaching practices as it relates to DGBL (Hayak & Avidov-Ungar, 2020). These technical factors have included the use of features of the equipment or software, organization of the equipment, and logistical planning. The organization of the equipment referred to the way teachers organize the computers and technology in order to teach with the software. Logistical planning referred to the steps necessary to learn the software plan the software’s integration with daily instruction. The features of the equipment or software referred to how teachers use the software to instruct such as navigation of the software. These technical factors align with Peddycord-Liu et al.’s (2019) teacher activities for integration of digital games into classroom instruction.
One feature prevalent in the present findings was the lack of reporting and real-time monitoring of student progress in IM. As evidenced in the qualitative findings, this limitation created much frustration for the teachers in terms of reteaching specific math content and providing documentation in parent conferences. The teachers lamented that if they had real-time monitoring of student progress, they would be able to isolate specific standards their students had difficulty learning, as well as provide evidence to parents how their students were progressing in math. Teachers (i.e., Rita and Darlene) expressed that some reports were accessible for students with individual education plans. These reports, they said, assisted with reteaching and monitoring students with individual education plans progress, but those reports were not available to all students and not useful for monitoring class progress. The use of student progress reporting was confirmed by Peddycord-Liu et al.’s (2019) findings where teachers used the reporting features in a digital game to inform their teaching practices, identify student skill deficiencies, and to share with parents. So, the lack of access to reporting in IM in the present study validated the teachers’ frustrations. Therefore, technical factors, such as features of a digital game, can influence teacher perceptions, and in time, teacher use of digital games (Hayak & Avidov-Ungar, 2020; Peddycord-Liu et al., 2019).

**Teachers Liked Digital Games That Were Easy to Use and Promoted Student Learning.** Recent studies have shown that teachers like to integrate digital games that are easy to use and promote student learning (Backlund & Hendrix, 2013; Becker, 2007; Becker & Jacobsen, 2005; Girard et al., 2013). The amount of time it took to learn a digital game was a hindrance for teachers according to Becker (2007). Moreover, Becker
(2007) went on to mention teachers used a digital game when they understood how to use it effectively and when the digital game promoted learning.

In this study, the teachers had mixed perceptions about the “ease of use” of IM. A few of the teachers mentioned that they liked the fact that IM was “user-friendly” for the students and that the teachers could easily integrate IM into their daily instruction (i.e., Darlene & Rita). These findings corroborated Peddycord-Liu et al.’s (2019) findings where teachers needed to meaningfully plan how to integrate a digital game into their instruction. In addition, the present findings helped to explain Yeo et al.’s (2022) survey results about teachers’ intentions to use digital games, where teachers’ perceived value of integrating a digital game may be impacted by how well it can be incorporated into existing practices. However, a couple of teacher participants stated that IM lacked certain features such as real-time student progress reports and navigation to the available reports was challenging (i.e., Nila and Rita). Rita commented that IM was “difficult to manage on the teacher’s side” and this made IM not user-friendly for the teachers. The more comfortable teachers are using a digital game, the more likely they are to use it (Charsky & Mims, 2008; Egenfeldt-Nielson, 2005; Gros, 2007).

Whenever a digital game is easy to use for the students, there is little need for teachers to manage students’ individual instructional needs or need for direct instruction on how to use the digital game. The teachers viewed IM as easy to use because students were able to use it independently. IM did not require constant supervision or direct instruction. In this study, the teachers allowed their students to use IM independently, with little to no teacher support (i.e., Liz, Nila, Rita and Sue). The teachers like the notion
that students can use IM independently and that makes IM an easy-to-use digital game for the teachers.

In terms of purposeful learning, teachers' perceptions have been positive when digital games promoted learning (Huang & Ke, 2009; Huizenga, et al., 2017). Teachers have used digital games because they understand that traditional teaching methods have not always engaged as much (Becker, 2007; Groff et al., 2010). In this study, the teachers liked it when students were using IM to learn math but stated that they did not know if improvements in student math learning could be attributed directly to IM. When asked about this, all five of the teachers answered that there was no way for them to tell if IM had an impact on the students’ math knowledge. As stated by Nila, “I can’t tell.” And as mentioned in the previous section above, the teachers attributed some of this due to the lack of reporting features in IM. The teachers also explained that since IM was not the only digital platform for math instruction, they could not distinguish if IM was the sole reason for student growth. For example, the teachers had grade-level math curriculum with Houghton Mifflin Harcourt and another DGBL tool Zearn Math as optional supplemental math program, which were provided by the district.

Implications

There are a few implications to this study. There are implications for me as the researcher, implications for practice and recommendations for action for the school and school district, and implications for further research. In the following sections, I describe the implications in that order.
Personal Implications

From this study, I learned much about research methods. I learned that an evaluation approach that utilized both the quantitative and qualitative aspects, brought more information to the study (Creswell, 2014). I also learned that literature review was critical to the study because it brings foundation from which the current study can springboard from. And since change always occurs at schools, isolating variables was a challenge.

I was not aware of how in-depth some of the research was about DGBL and discovered findings that were expected and other findings that were interesting. These findings have better equipped me to handle personal decisions, such as what type of digital games to purchase for my children, and professional decisions, such as what types of digital games are better suited to student learning.

The findings about how motivation and engagement promote student learning in math, which were not measured directly in my study but discussed by the teachers, did not surprise me. For example, Liz and Nila mentioned that their students loved building avatars and Rita mentioned that her students liked playing IM and had to turn IM off at times. It is typical of today’s generation due to their high level of curiosity and adaptability to technology. The finding about how teachers perceived IM was quite interesting. Given IM’s success in other districts, I did not expect our teachers to perceive that IM’s impact on students' math knowledge to be inconclusive.

Implications for Practice and Recommendations
One reason for this study was to collect teachers’ perspectives on how well IM was working for them and their students. From the qualitative analysis, the teachers’ perceptions were mixed regarding how effective and capable this tool was for both teacher participants and their students. This would imply that teachers would prefer it if the district researched possible alternatives and moved forward with that selection. This selection would be a DGBL tool that included real-time and customizable reporting according to the teachers.

As a math supplemental tool for the school district, IM has been a significant expense for the district and has had technical issues. IM costs more than the grade level math curriculum program and other supplemental math applications the district has considered, such as Zearn. Technical issues have been a recurrent issue for the technology staff and teachers, and technical issues have caused an inconvenience for teachers. The school and district staff should explore other alternatives for math instruction supplements. This study did provide some background into this search and identified required features for any digital math supplemental tool. Some of these features include ease-of-use and student progress reporting in real-time according to the teachers. From a technical perspective, fewer technical issues include rostering, uptime, and responsive technical support.

**Implications for Future Research**

There has been research on DGBL in mathematics learning (Berrett & Carter, 2017; SEG, 2019; Snyder, 2016; Takeuchi, 2014). Some studies investigated the impact of using math based DGBL on the standardized math assessments (DeLeon, 2020; SEG,
2019; Snyder, 2016). Other studies examined math DGBLs and student growth within the program (Berrett & Carter, 2017) and other studies investigated quasi-experimental and survey-based methods into the effectiveness of DGBL (All et al, 2014; O’Neil, Wainess, & Baker, 2005). If I was to perform a second cycle of action, I would isolate the other variables such as the use of Zearn and provide a longer duration for the study to obtain more data.

Future research should include how IM has impacted state mandated tests. There have been a few studies about the effectiveness of IM (e.g., De Leon, 2020; SEG, 2019; Snyder, 2016;) on standardized tests but none about how IM would impact CAASPPs specifically. It would be beneficial for educators to know if there is a direct correlation between the use of IM and any math fluency gains in CAASPP. Other future research topics could include IM’s impact on distance learning and longitudinal studies on IM and how it impacts students and demographics.

Another possible future research could include students’ perceptions about the use of IM. This would provide data about how students perceive IM and its use for math learning. Snyder (2016) mentioned that students are excited about using IM but there is little research on this topic. It would also be beneficial to compare students’ perceptions with teachers’ perceptions. This might provide some data to retain or look for other digital math solutions.

**Limitations**

While there are possibly many limitations of this study, five prominent for this study are (a) duration of the study, (b) different levels of math knowledge of the student
participants, and (c) the mediating effect of engagement and positive reinforcement of the use of IM and (d) the use of other supplemental math tools or learning activities and (e) qualitative data was not collected from the students.

This study was conducted over a semester. However, as mentioned in the implications section, a longitudinal study might reflect more comprehensive data (Nese, Lai, & Anderson, 2013) as it relates to the impact of IM over a longer period. The longer the duration of the study, the more qualitative and quantitative data could be gathered. This would allow the researcher to isolate the variable and look for patterns over a longer period, thus, allowing for sudden changes and other unknown variables (Nese, Lai & Anderson, 2013) and track students’ math progress across grade levels. This would reinforce or refute the findings, given the longitudinal nature of data collection.

The students had different levels of math knowledge, and this was not measured in the study other than with the pretest-posttest design. In relation to significant gains in math knowledge, the study presented grade level overall results only. A more sophisticated study design, such as with a covariate or repeated measures with three or more data collections, would improve the quality of the findings. It might also be beneficial, as mentioned in future research, to see if the different levels of math knowledge were impacted using IM. For example, it might be valuable to see how students who were not on grade level compared to their peers or how students who were higher achieving in their math knowledge compared to their peers. Another benefit would be to know if this would be similar across the board for all math knowledge proficiencies. Also, because this study was conducted at one school, it would be useful to determine if these findings generalize to other schools in the district.
The mediating effect of engagement and positive reinforcement of the use of IM was not measured in this study. Two of the three standards showed significant growth in this study, but other variables such as student engagement and positive reinforcement were not measured. These variables may have contributed to the students’ math growth. The IM program according to the teachers was engaging to the students and acted as a positive reward system as the students liked building their avatars and wanted to stay in the program.

Another limitation would be the availability and teachers’ use of other free or district-supplied math supplemental tools, such as Zearn Math and other learning activities. In addition to the district mandated grade level math curriculum (i.e., Houghton Mifflin Harcourt) and IM as a supplement, teachers also had access to Zearn Math, which was approved by the school district for use but not mandated. Some teachers preferred using Zearn Math and this may have impacted the findings. Use of other tools was not prohibited, controlled for, or measured in this study. There was no data to verify that Zearn Math impacted students' knowledge.

The last limitation would be the fact that this study did not collect students’ perceptions about the use of IM for math learning. This would provide greater qualitative data into how both the student and teacher samples perceived the program and its use. This would also give the school district and researcher a better understanding of how this program is perceived overall. This would help in the decision making process for IM and other future digital math programs.
REFERENCES


comprehensive evaluation report. Gibson Consulting Group. Retrieved from:


Li, W. & Huang, Z. (2016). The research of influence factors of online behavioral


Takeuchi, L, & Vaala, S. (2014). Level up learning: A national survey on teaching with

The Hechinger Report. National Test Scores Reveal a Decade of Educational Stagnation.

The Nation’s Report Card. Data Tools: State Profiles. State Performance Compared to
stateprofile?chort=1&sub=MAT&sj=&sfj=NP&st=MN&year=2017R3

http://www.timelesslearntech.com/learning-platform.php


for literacy. Reading Research Quarterly, 30(3), 410–441.

Turkay, S., & Kinzer, C. (2013). The effects of customization on game experiences of a
massively multiplayer online game’s players. In C. Williams, A. Ochsner, J.
Dietmeier, & C. Steinkuehler, (Eds.), Proceedings of GLS 9.0: Games C Learning


APPENDIX A

DIAGNOSTIC BENCHMARK

1. This array shows the total number of coins Brooklyn has in her wallet. Using multiplication, find how many coins Brooklyn has.

2. Web Only Interaction

3. The soccer coach has 20 cones. Each group of players will need 4 cones for soccer practice.

4. Decide whether each equation has the same unknown value as \(7 = 35 + \square\). Choose Yes or No for each equation.

5. Decide whether each equation has the same unknown value as \(42 = \square = 6\). Choose Yes or No for each equation.

6. A builder is using large rocks to build a wall. Each large rock has a mass of 4 kilograms. The builder puts 7 of these large rocks into a wheelbarrow.

   What is the mass, in kilograms, of the rocks in the wheelbarrow?

7. The bell for the start of school rings at 8:35. Michelle got to the school playground at 8:10. How many minutes did she have to play?
   A. 10 minutes
   B. 25 minutes
   C. 35 minutes
   D. 45 minutes

8. Use the number line below to solve the problem.

   Sonya leaves school at 3:00. It takes her 15 minutes to walk home, 20 minutes to walk the dog and 10 minutes to eat her snack before she can start her homework. What time will she begin her homework?

   A. 3:15
   B. 3:25
   C. 3:35
   D. 3:45
9. Mrs. Chen left work at the time shown on the clock.

She walked for 10 minutes to the nearest bus stop. Then she rode the bus for 16 minutes. Three minutes later she was home. Which clocks show the time Mrs. Chen arrived at home?

Choose the TWO correct answers.

A. 

B. 5:15

C. 

D. 5:34

E. 5:31

F. 

10. Grace is making cookies for her 12 friends. She wants to make sure each cookie is exactly the same size. The mass of her cookie batter is shown below.

Use the drop-down arrows to choose the response that makes each statement true.

11. Greta measured a can of soda on the scale below.

What is the mass of the can of soda?

A. 250 grams
B. 290 grams
C. 310 grams
D. 350 grams
Directions: Answer the following question(s).

12. Josh needs to fill a large bathtub with water to wash his dog.

Which measure is a reasonable estimate for the amount of water Josh needs to fill the tub?
A. 4 liters
B. 14 liters
C. 140 liters
D. 4,000 liters

13. Look at the number sentence below. Which number will make the number sentence true?
   \[4 \times \square = 40\]
A. 8
B. 9
C. 10
D. 40

14. There were 18 apples on the table. The apples were all put into 3 equal groups with no apples left over. Which sentence about the number of apples in each group is true?
A. \[18 \div 3 = \square\] so there are 4 apples in each group.
B. \[18 \div 3 = \square\] so there are 5 apples in each group.
C. \[18 \div 3 = \square\] so there are 6 apples in each group.
D. \[18 \div 3 = \square\] so there are 7 apples in each group.

15. Mrs. Evan’s third grade class was creating an art project for the bulletin board. It was going to be a tree with colorful leaves. The class decided on cutting out 150 leaves. On the first day, 86 leaves were cut out. How many more leaves needed to be cut out on the second day?
A. 36 leaves
B. 64 leaves
C. 74 leaves
D. 136 leaves

16. Henna has a total of 20 postcards. She puts them into 4 equal groups. Which statement about the number of postcards in each group is true?
A. There are 3 postcards in each group because \[3 \times 4 = 20\].
B. There are 4 postcards in each group because \[4 \times 4 = 20\].
C. There are 5 postcards in each group because \[5 \times 4 = 20\].
D. There are 6 postcards in each group because \[6 \times 4 = 20\].
Directions: Answer the following question(s).

17. Which of these could show the number sentence below?
   \[20 - 5 = ?\]
   Select all that apply.

A. \[
\begin{array}{cccc}
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\end{array}
\]

B. \[
\begin{array}{cccc}
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\end{array}
\]

C. \[
\begin{array}{cccc}
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\star & \star & \star & \star \\
\end{array}
\]

18. Which of the following equations is true?
   A. \(5 \times 8 = 58\)
   B. \(5 \times 8 = 5 + 8\)
   C. \(8 \times 5 = 5 \times 8\)
   D. \(8 \times 8 \times 8 = 8 + 8 + 8\)

19. Which expressions are equal to \(3 \times 6 \times 1\)? Select ALL that apply.
   A. \((1 \times 3) \times 6\)
   B. \(3 + 6 + 1\)
   C. \((3 \times 6) + (3 \times 1)\)
   D. \(6 \times 1 \times 3\)
   E. \((6 + 1) \times (1 + 3)\)

20. Which expressions are equal to \(5 \times 2 \times 7\)? Select ALL that apply.
   A. \(5 \times 7 \times 2\)
   B. \(7 + 2 + 5\)
   C. \((2 \times 5) \times 7\)
   D. \((5 \times 7) + (5 \times 2)\)
   E. \((5 + 2) \times (2 + 7)\)

21. Look at the clock.

\[
\begin{array}{ccc}
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9 \\
10 & 11 & 12
\end{array}
\]

What time does the clock show? Tell how you know.

22. A farmer picked 24 kilograms of apples. He is selling the apples in baskets of 3 kilograms each. How many baskets will he be able to fill?
Dear Pooze Lee,

This is to certify that research study entitled ‘Increasing Math Knowledge With Imagine Math’ was reviewed on 1/10/2022 by the Office of Research Compliance, which is an administrative office that supports the University of South Carolina Institutional Review Board (USC IRB). The Office of Research Compliance, on behalf of the Institutional Review Board, has determined that the referenced research study is not subject to the Protection of Human Subject Regulations in accordance with the Code of Federal Regulations 45 CFR 46 et seq.

No further oversight by the USC IRB is required. However, the investigator should inform the Office of Research Compliance prior to making any substantive changes in the research methods, as this may alter the status of the project and require another review.

If you have questions, contact Lisa M. Johnson at fisher01@uvic.ca or (803) 777-6570.

Sincerely,

Lisa M. Johnson
ORC Assistant Director and IRB Manager
APPENDIX C

DISTRICT CONSENT LETTER

January 4, 2021

To Whom It May Concern:

I give my permission for Paoze Lee, technology systems director, to perform the research study on Imagine Math at one of our elementary schools. I understand that this will involve teachers and students from 3rd grade in regards to the Imagine Math program and the use of benchmark data from Illumnate.

If needed, the researcher, Paoze Lee, will obtain consent forms from the parents. I understand that the study will include observation of teachers and students using the Imagine Math program and an interview with a teacher focus group. It is also my understanding that the research findings will be shared with staff and the community.

Sincerely,

[Signature]

[Position]

[Date]
APPENDIX D

FOCUS GROUP INTERVIEW TRANSCRIPT

Imagine Math Interview
05/03/22

Rita: Um
Paoze: So
Rita: was we, we liked having it
Paoze: Ok
Rita: because we do not have an an an additional intervention piece for our students.
Paoze: Ok
Rita: Um because the other math that we have is at their level, the third grade material.
Paoze: Ok
Rita: So this is the only thing we have to supplement for their needs.
Paoze: Gotcha
Rita: Um, so I think that one of the discussions. The other part was, it’s difficult to manage on the teachers side, it’s not teacher friendly for like
Paoze : Ok
Rita: the reports that we would like to get.
Paoze: umhumm
Rita: Um, but it’s also good to be able to have students doing something independently that they don’t need us to be able to do the program.
Paoze: Gotcha, gotcha and thanks for the summary. Let me just kind of go over the questions just so I
Rita: Ok
Paoze: once again I have more of a
Rita: Umhumm
Paoze: So what are some success stories that you would like to share about Imagine Math? And feel free to chime in at any time.
Rita: Success was um, that the students are are excited
Paoze: Ok
Rita: about the program
Paoze: Ok
Rita: and they look forward to seeing their sssc… the whatever incentives are built in and they like seeing how they compare to kids in the classroom and in uh across the grade level.
Paoze: Ok, anything else to add to that Mrs?
Nila: They also like the activities and the games
Paoze: Ok
Nila: very much so.
Paoze: What are your thoughts about the the the program itself?
Liz: It’s not user friendly as far as teachers go.
Nila: no
Paoze: Ok
Liz: Um it’s. It doesn’t update um, in real time. So, if you want to see if they were working the amount of time you told them to work today, you can’t until the next day so
Paoze: Gotcha
Liz: that’s, that’s a frustration for me, um… yeah.
Sue: [clears throat] Yeah I think it’s the same for me I, I feel like it does. Like I send it to the students and they are able to do it and I could see like their, they get excited as they keep moving up, but then um, you have to see the reports or just if they ask me like, “how am I doing?” and then it’s um, you know it’s really hard to go around looking around to see where we’re supposed to go to get um to. Like I don’t know the information and sometimes when I try telling the parents how they’re doing I also struggle just finding, like ok “where do I go?” and “how do I get this?”. Maybe I’ll see it one time and next time I can’t get there…so.
Paoze: How useful is the program in terms of reteaching concepts? Why or Why not?
Nila: We, we can’t because if we can’t look up the scores, if we can’t, it’s not teacher friendly, then how can we reteach?

Paoze: Right

Nila: you know

Liz: And they’re all kind of working at their own level so it’s more of a um differentiated you know, independent program than than something you can do altogether as a whole group

Rita: If I were to use it to reteach um, then that would come, that, it would no longer be a supplemental program for me. I would have to learn the program itself, so I don’t use it that way. I just let the kids um, work on it independently again because it’s at their level, you know.

Darlene: It’s really good for where who having these kids still going out on isolation,

Nila: Umhumm, yes

Darlene: it’s one of those good things that “ok, you know what complete 20 minutes in Imagine Math”, because it’s at their level. If they do need help, they can you know, they have the little teacher function where they can ask the teacher for help and they’re not trying to do whatever we’re currently doing the next lesson like on Zearn by them self or without like that additional support. So that’s what, like that’s how I use it. It’s just like you know what you are at home this is what you could do.

Nila: Another thing is, some of us use it like when we we’re doing guided reading we can have it on there after they are done with completing Zearn, they can go to Imagine and work on it and I like it because it is at their level that you know, cause we’ve got some really low students so this works with them on that.

Paoze: Gotcha

Nila: But again, it would be nice to be able to just know where to go to get the reports to see where they’re at and what they’re doing.

Liz: And I don’t send homework so for my students who are like in assets, you know the assets program they, they want the children to have homework and then there are some parents who want their children to do work. So it’s good for that you know, they can log into the Imagine programs um, there in assets or at home.

Paoze: Uh thoughts on the rewards and engagement, I know you guys touched upon this earlier

Liz: They really

Paoze: Um
Liz: loved building their avatar. I let them do that on Friday’s. They like um, you know they earn the points for each lesson they complete they earn the points and the credits and they can decorate their little avatar. They like doing that. Yours don’t do that?

Darlene: I don’t use it enough in the classroom so I have no [several inaudible words], good for you

Liz: I have to lock it, I have to. That’s the one thing I know how to do. I have to lock it so that and only open it up at a certain time otherwise they’ll play with it all the time. But um, yeah they enjoy doing that. They get to dress them in different outfits

Paoze: Yeah

Liz: Yeah

Paoze: I know you guys talked, talked or touched upon the navigation but can you kind of, uh, uh any any um comments on navigation in terms of report features, movement or no report features if you will.

Rita: There might be a report feature but I can’t find it.

Paoze: Ok

Rita: [Laughing]

Rita: I’m not familiar with doing that. Maybe if I searched enough I might find it, but what I would like to see is um. I want to pull up a student or the whole class just to kind of see where they are. What they’re working on as a class. I know that it gives me a, um, you know intervention these are the kids that need it. But it only lists a couple of kids at a time and I can’t really see like the bigger picture.

Paoze: Gotcha

Rita: So report wise, no

Paoze: Anything else to add to that?

Nila: Yeah it’d be nice to just see the visual, you know where they’re at individually too to see where their, you know.

Paoze: Gotcha

Rita: But again, I don’t, I don’t really don’t want to because then it becomes more of a teaching.

Nila: Unless it were easier to access, because it’d be something to show parents at conferences you know too, where there, you know look at their own kid at kindergarten level and they should be doing 3rd grade level stuff.

Rita: I do like their, there is a report that I use for, especially for SST’s is where it gives me uh, this is how many lessons they’ve passed, this is how much um, how many they’ve
attempted but it, there is a another part that says this is what they’re working on. These are the skills they’re working on. That report I do like, but again it just takes time to get to it.

Paoze: Gotcha. Um, we’ve had the program for about, about, I’d like to say 3 years if I’m not mistaken, 3 years now. Um, do you feel it’s making a difference? And once again guys, tell me how you feel. My goal is to be agnostic, to say you know what this is how the teachers feel about it. I’m not going to say, “Mrs. so and so said this”, that’s that’s not my goal. My goal is to, should we keep this or should we can it. It does cost us uh a good chunk of money.

Rita: So I don’t know if it’s making a difference personally, because it can be a combination of how the students, if it were pandemic it would be a whole different story. Um, but you know it, it could be a combination of how we’re more across level and are, or you know from K uh to here that they’re they’re using the same math program we are now. We’re kind of more in sync too, how we’re teaching and the the language we’re using. Um, I do. The the suc…suc… ss… success part is; I like that they’re using it at DPE so that when they get here they’re more familiar with it. Um, I don’t know what else.

Sue: I think for me it would be hard to say if it is or not, because I feel like um, there’s like uh, kind of a lack of consistency to where I can’t say yes or no because I know like every sometimes we don’t get to do it in the day and other times I try to have them like everyday. Like at least 15 minutes, but then um, I know some students don’t get to it because they like leave class at that time or come back. So I feel like it’s different and then I know we do it like across the grade level. Like some of us might use it more than others, so then we can’t even compare like our classes to see what like, you know. So I feel like it’s not consistent you know.

Darlene: Yes, I, I want to say I don’t think I use it enough in the classroom to like even determine if it’s going to be

Paoze: Ok

Darlene: kind of important or anything.

Paoze: Gotcha, ok. Um [clears throat], and I was, you guys touched upon this too, but do you guys think that the program allows you guys to focus on the specific math knowledge of your students individually? And this goes back to reporting features I think you guys were talking about

Sue: Say that, say it again.

Paoze: Do you think the program has impacted the student’s math knowledge and are you able to like view their

Rita: I can’t teach that

Paoze: levels on a specific level

Nila: I can’t tell
Liz: me either
Paoze: Ok
Teachers 1: I can’t teach that, can you guys?
Nila: no cause
Liz: I, I wouldn’t…yeah
Paoze: Ok, thank you. Um, anything else you guys would like to add?
Rita: If if um, if this is som…I know that it costs you know, it may not be cost effective. Um, if this is something that we are looking into not getting um, what would take the place of for that tier 2 and tier 3 for the math?
Paoze: That’s a good question, I… I… I definitely want to take that to back to Mr. Mendez and Mrs. Grijalva. Um, my goal with this is to see what source is not working out. My understanding, your question Rita is, how do we help those kids that are really behind
Rita: Yes
Nila: Yeah
Paoze: And that’s that’s where this comes in
Rita: Right
Nila: Yes
Paoze: Um and once again I am not math teacher, I’m just, I used to be a science teacher back in the day. But um, my thinking is that’s where you go to the publisher’s, publisher’s and say you know Eureka or Zearn, because Zearn is where
Rita: umhumm
Paoze: my understanding Zearn it is working. Why not use those companies that are working and say “hey, what do you guys have for tier 2 or tier 3?” They might have something that’s there. Why are we using something that isn’t, you know, working to the full ability that all of us agree or don’t agree on. Or you know, whatever it is and you know ask Zearn or ask Eureka math, “hey, do you guys have something’s out?” You know publisher’s
Rita: Right
Paoze: they, they’re in there to make money
Rita: Right
Paoze: They’re not, yeah so yeah. That’s
Rita: But as far as like the friendliness and the independent for the kids, I love that part of it. I love that I’m able to just plug it in and then use it throughout the day.
Paoze: Yeah
Rita: Awesome to be able to have it for the small groups.
Paoze: Umhumm
Rita: Um, because again it gives them something that they need at their level.
Paoze: Umhumm
Rita: Um, I’m wary about saying I don’t want it next year
Paoze: Right
Rita: because what am I going to do?
Paoze: Right
Rita: Especially at the way that you know
Paoze: Right
Rita: these last two years.
Paoze: Right
Rita: There’s, there is a big gap.
Nila: We need it.
Paoze: Right
Rita: You know, what if, what is it that we need to do?
Paoze: Right
Rita: And I don’t want to learn something new.
Paoze: Right
Rita: Right now
Paoze: True
Rita: [laughs]
Nila: Well um because we do have, we have our reading, our
Rita: Right
Nila: you know our guided reading groups plus we have Winn for language arts reading
Paoze: Umhumm
Nila: But yet we don’t have anything for the low ones in
Paoze: Right
Nila: math except for Imagine
Paoze: Right
Nila: so
Paoze: Right right and once again, I understand where the concerns are at from all angles. My goal is not to say
Rita: Right
Paoze: “let’s let’s can this quickly, let’s let’s look at the numbers. Let’s look at the, let’s let’s let’s you know let’s do the folks who are in the trenches doing this. Let’s, what’s working and what’s not working and take that back and check with Eureka, check with Zearn before we go. Can it. Worst-case scenario we run this for another year. We do our research during that year and say, “alright we are happy with Zearn’s you know answers for folks in two or three or you know Eureka’s two or three”. That’s how I would approach it once again as a group if you guys. Once again, I’m open to suggestions. If I take this back it’s more of a, “the teachers are saying this about it, but this is too short of a notice. Let’s keep it for another year and then we’ll can it a year after or we keep it because there is nothing else to replace it you know”. But we ask for them
Nila: You know we used to have iReady and that was a lot more teacher friendly and I think teachers, kids like that and all of a sudden that was shut off and here comes Imagine.
Paoze: Yeah, and don’t quote me on this Mrs. Powers but yo… you might like what you are going to hear about that very soon. It, iReady is coming back and so, but don’t quote me on that, that’s
Darlene: There’s still some days I call that
Paoze: Yeah
Darlene: iReady
Paoze: Yeah
Darlene: So I’m like you know what the kids are like
Paoze: So don’t
Darlene: yeah, I don’t want to talk about it. I’m like
Paoze: So once again, don’t say Paoze said this but there there’s conversations regarding iReady.
Nila: It was a lot more
Paoze: Yeah
Nila: teacher friendly wasn’t it
Paoze: It was it was and the only
Rita: How long ago I don’t know
[Laughter in the background]