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The Implementation of Math Technology Supplemental Programs for Elementary Students

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
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Walden University
2020

Abstract

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MA, University of New Mexico, 1992

BA, Williams College, 1990

Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Many studies have focused on using technological devices in elementary education; however, more research is needed on the implementation of technology to improve student learning in math. The problem addressed in this study was the lack of information about how teachers implemented and used the new math software programs, Imagine Math and Reflex in their instruction and their perspectives on differences the programs made in students' math learning. The Technological Pedagogical Content Knowledge (TPACK) served as the conceptual framework for this study. The purpose of the study was to understand how teachers are using the new math software programs and to analyze their perspectives on differences they notice in students' math learning and comfort with online math tools after using the programs. This qualitative case study used data from interviews and observations from local teachers to illuminate the positive and negative aspects of implementing the new software programs. The data were coded into theme categories including usage, strengths, concerns, and professional development. The data showed the participants had generally a positive view of integrating the programs and felt the programs were beneficial to students, that the biggest challenges were lack of training and some technological issues, and TPACK changes were more prevalent for program-experienced teachers and limited to center time for those new to the programs. The finding helped identify the gap between what the math technology programs claim and what the programs actually do for teachers and learners. The potential for social change is to accurately capture the programs' benefits to students and the preparation required by teachers for online learning programs and assessments.

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Dedication

This project is dedicated to my family who supported me through the process and to my school family who I hope to benefit from the research and study. Thank you for your support, assistance, and encouragement.

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There are many people I would like to acknowledge for supporting me and helping me continue through this process. First, I would like to acknowledge my doctoral chair, Dr. Heather Caldwell. Her guidance and support allowed me to continue the process and work through barriers. She provided guidance, compassion, and expectations that coached me through the process. I would like to acknowledge Dr. Michelle McCraney for accepting the responsibility of becoming my second member and providing me assistance and suggestions to finish my project study. I would like to acknowledge my committee member, Dr. Kimberly Strunk for her reviews through the beginning stages. I would also like to recognize Dr. Bonita Wilcox, my University Research Reviewer committee member. I want to thank the Walden students who have been working through this process with me. Finally, I would like to thank my family, co-workers, and friends for their assistance in peer reviewing and editing my work.

I would like to thank my family for their patience and support through this endeavor. I also need to thank my principals, colleagues and the administration from my district for providing me encouragement and time for this study. I want to thank the students who have been working through this process with me.

Table of Contents

List of Tables

Section 1: The Problem

Introduction

There are many challenges and opportunities for integrating technology into the educational setting. In a review of reports, the following three key themes for investing in educational technology were identified: technology as a tool for addressing the challenges in teaching and learning, technology as a change agent, and technology as a central force in economic competitiveness (Culp, Honey &Mandinach, 2005). Recommendations found for supporting and sustaining the technology effort included improving infrastructure, creating high quality software, providing sustained professional development, increasing funding, promoting roles of stakeholders, increasing research evaluation, and assessment, and revising school policy. Culp et al. (2005) who found an increase in virtual learning environments, identified the continued need for producing innovative, quality, online and digitized content that emphasizes appropriate pedagogy. Although technology began to make its way into educational studies a couple decades ago, it is still at the front of many current studies and trends**.** The integration of technology is noted by Davis (2016) stating that the Software & Information Industry Association reported that pre-K-12 schools spent $8.3 billion on educational software and digital content in 2014.

While technology can expand, and extend the scope and depth of teaching, teacher professional development was recognized as the single most important step toward the integration of technology (Culp et al., 2005). Killion (2015) found a moderate to significant association between students' math achievement with professional development in math content, pedagogy, curriculum, and technology integration. Ongoing assistance and professional development is necessary for integration of technological skills and pedagogical knowledge (Ertmer & Hruskocy, 1999) and has positive influences on student achievement (Killion, 2016; Kiriakidis & Johnson, 2015). The support system is necessary not only for initiating, but also maintaining implementation efforts (Urbina & Polly, 2017). Ertmer and Hruskocy (1999) identified professional usage and instructional usage as two types of integration and found that an increase in the instructional usage was associated with the increases in comfort, confidence, and interests of the teacher. Hsu (2016) identified teachers' lack of support as a barriers to technology integration. However, Ertmer and Hruskocy (1999) concluded that developing internal sources of support as well as collaboration can minimize the difficulties encountered in integrating technology.

Ertmer, Addison, Lane, Ross, and Woods (1999) identified first-order barriers as extrinsic types of resources and second-order barriers more as intrinsic beliefs related to the teacher. In recent years, the first order barriers have begun to decline with several recent one-to-one initiatives and iPad integration in the schools (Zheng, Warschauer, Lin, & Chang, 2016; Herald, 2016; Stacy, Cartwright, Arwood, Canfield, &Kloos, 2017; Barbour, Grzebyk, & Grant, 2017; Al-Mashaqbeh, 2016; Musti-Rao &Plati, 2015, Tucker & Johnson, 2017). The rise in one to one initiatives was driven by both the new mandated online state tests and extensive adoption of Common Core State Standards (Herald, 2016). Furthermore, Ertmer et al. (1999) argue that the continuum of technology integration begins with supplemental usage during students' free time which is used most frequently (Urbina & Polly, 2017), progresses to support curriculum where concepts are reinforced, and ends with facilitation of enrichment where students can go beyond the current curriculum. Polly (2015) found the level of computer math tasks used influenced the students' mathematical representations and communication.

According to a meta-analysis that reviewed 94 articles and dissertations on one-on-one technology initiatives from 2001 to 2015, laptop environments can increase academic achievement as well as technology usage for varied learning purposes. However, there is still a need for more studies that can better systematically identify what works and what does not (Zheng et al., 2016). Zheng et al. noted that only ten of these studies met the researchers' criteria demonstrating the limited research on student computer initiatives.

In 2017, about 80% of students took the National Assessment of Educational Progress (NAEP) test on digital devices, and a technical analysis found states new to the online format had larger average declines which could account for up to 11 percent of the change in 4^{th}-grade math scores (Sparks, 2018). Sparks reported that most states have moved to computer-based assessments and students' familiarity with digital devices is increasing. Davis (2018) reported that most principals embrace the concept of using technology for personalized learning because it makes differentiation more efficient for teachers and seems to improve student engagement, but principals are also concerned that it could contribute to students spending too much time on screens.

The Local Problem

The mandated New Mexico state assessment for public schools changed in 2015 from a paper and pencil assessment to an online format called the Partnership for Assessment of Readiness for College and Careers (PARCC).The new test is rigorous as it added more evaluation of critical thinking, problem-solving, and effective communication skills including writing about their process for solving problems (PARCC, Inc, 2016). The problem of practice to be addressed in this study is the lack of information about how teachers use the new math software programs in their instruction and their perspectives on differences it has made in students' math learning at Sage Elementary School (pseudonym). Students were unprepared for the new 2015 state online assessment as demonstrated by a 25% drop in proficiency in math with the lowest scores in the areas requiring writing about math (NMPED, 2016). According to Herold (2016), the PARCC consortium said some score differences and drops might be due to lack of familiarity with the new online testing format.

The New Mexico Public Education Department (PED) predicted there would be a decrease in test scores in 2015 due to the new format as well as being a more challenging assessment (NM First, 2016; Latham, 2016). PARCC is a nationally recognized test developed by Achieve to measure how well students understand and apply the skills and standards from the Common Core State Standards (CCSS) in math and English language arts (NM First, 2016). The short answer portion of PARCC requires keyboarding skills and knowledge of the program functions, and there has been much discussion about test validity when students are not able to keyboard as well or quickly as they can write with a pencil (Harvey, 2014). Harvey commented that students need to have keyboarding and computer skills to be better prepared to take the required computer New Mexico Standards Based Assessment (SBA).

Latham (2016) noted the PARCC questions expand the types of questions that can be administered to probe for student's depth of understanding. Constructed response and multiple select items that use various technological innovations, and performance tasks requiring extended thinking with modeling, comparing, and problem-solving are used within the exam. However, many students have not had training with this type of computer assessment. Latham clarified that with the new format, students must have a full understanding of the concept to select the single correct combination. By 2016, PARCC provided example questions and online tools so students could have access to samples prior to taking their test.

Evidence of the Problem at the Local Level

Focus areas from the new strategic plan for the district include student well-being, student learning, teacher and staff excellence, fiscal responsibility, quality facilities, innovative leadership, communications and collaboration, and integrated technology (LAPS, 2016). According to the district state assessment data report, the overall proficiency rate in 2014 was about 85% proficient in reading and 77% proficient in math (LAPS, 2016). A better picture of the district's performance is discerned if the proficiency rates are broken down further by subject, school and grade level. The state assessment test changed from the paper SBA in 2014 to PARCC in 2015, and the proficiency results dropped enormously for all districts and states using PARCC (LAPS, 2016). At the district level, the reading proficiency had a 12% to 30% decline in proficiency throughout all schools. The proficiency levels in mathematics dropped from 29% to 33% at all schools compared to the previous year. There was little change in the scores from 2015 to 2016. Such a drop in proficiency warrants a look at the curriculum and changes expected to adjust to the new assessment methods.

For the local New Mexico district, Sage Elementary School is the smallest of the five elementary schools. The population for Sage is about 285 students with great diversity. Since Sage is the smallest district school it has the largest number of out-of-district students with a higher proportion of low socioeconomic and Hispanic students than most of the other district elementary schools. The district's continued emphasis on reading sustained a higher percentage of student proficiency in reading compared to math on the new state assessment.

For Sage Elementary, the lack of technology integration for mathematics content and writing about math continues to be a concern. One fourth grade teacher complained that several of her students typed only an answer with a couple of words when they were asked to explain their process for solving the problem, and that other students wanted to draw picture explanations to match their work but only had a typing box, so they just typed the numerical answer (M.Mann, personal communication, April 12, 2017).A third-grade teacher added that students did not answer all the parts of the questions (S.Jiron, personal communication, April 12, 2017). The principal stated "the 2015-2016 PARCC scores at Sage Elementary are low, no grade level scored above the 60th percentile, with 5th grade students scoring at about the 45th percentile" and that the goal for 2017-2018 will be to achieve 70% proficiency in math (S. Lynne, personal communication, April 18, 2017).

The principal wants to utilize number talks and the Think Through Math (TTM) online program to help improve number sense, communication about mathematics, critical thinking, and familiarity with an assessment format similar to the PARCC assessment (S. Lynne, personal communication, April 18, 2017). Think Through Math (TTM) is a web-based math program that was developed and aligned with the new state test and provides a similar computerized testing format. However, the TTM program does not use online writing but rather recommends a journal notebook and format.

Therefore, this study analyzed how teachers are setting up, activating and implementing the new software programs, Think Through Math and Reflex, in their instruction and monitoring their perceptions of changes in students' abilities and communication about mathematics. After an exhausted search, there is no evidence of research conducted locally to monitor or evaluate the usage and implementation of the math technology programs. It is also unclear whether the teachers have had enough training, professional development, and support to implement the program successfully. No information has been gathered from staff to determine if the programs are useful for helping improve the areas of concern identified through the assessment data in math. Educational technology serves as a means to improve opportunities for students and staff. Technology support and investigations have increased in the elementary school settings. Technology serves as a means to increase innovation that provides greater efficiency and productivity.

The district lists digital technology as essential for successful teaching, learning, and management (LAPS, 2016). Effective integration of technology will accelerate student learning and foster 21st century skills. Technology can allow for innovative ways to meet student needs. Identifying student needs in math was a beginning step to develop and provide professional development (PD)to meet the district goals. In the fall of 2017, the superintendent met with several elementary math teachers during one of the grade level meetings to review the latest PARCC data and identify patterns that could be useful. The superintendent led a presentation about using evidence statement analysis to look at each of the grade levels and identify specific areas of concern for math to help inform curriculum and instruction (K.Steinhouse, personal communication, November 8, 2017).

Evidence of the Problem at the State Level

In addition to being a local concern, the use of online assessment formats is also a concern at the state level. New Mexico continues to rank near the bottom in the nation for student performance. “By 2020, most New Mexico students will not have the education, credentials or degrees required to fill 63 percent of the state’s jobs” (NM First, 2016, p.4). New Mexico ranked 50th on the National Assessment of Education Progress (NAEP) assessment for fourth-grade math but had made an increase of 8.6 percent from 2003 to 2015 (Uyttebrouck, 2016).

New Mexico saw a large drop in the number of students scoring proficient on the state exam when PARCC became the new standardized test. The state average of proficiency in math dropped from 40.7 percent to 23 percent after the switch to PARCC (Quintana, 2015). In 2015, the Every Student Succeeds Act (ESSA) was signed into law, replacing the previous 2002 law, No Child Left Behind (NMPED, 2018). The ESSA gave states more oversight over their education policies including testing (Burgess, 2017). In 2009, Achieve which established PARCC and the Smarter-Balanced Assessment Consortium received grants from the US Department of Education to support the development of an assessment system. Both of these consortia adopted the Common Core State Standards (CCSS) as the basis of their online test development (Lee& Wu, 2017). The New Mexico Department of Education chose PARCC for the state to use for standardized testing despite protests with student walkouts in 2015, comments of disappointment from districts throughout the state, and opposition from both of the state's teacher unions (Burgess, 2017). Democratic State Senator Howie Morales has called for the removal of the PARCC test in New Mexico, labeling it an expensive failure for the state (Morales, 2018). Morales stated the millions that have been funneled to the corporations for PARCC tests and technology should be used for proven methods of bettering education.

The PARCC assessments are based on the CCSS. Although the CCSS launched in 2009 helped America raise the performance standards by having states adopt uniformly rigorous standards, the upgrade to standards by itself did not improve students' performance results (Lee& Wu, 2017). Lee stated the failure to improve assessment scores were likely related to the schools' lack of aligning CCSS with the programs and curriculum being used in the schools. The results from Lee& Wu's study show there is still a large gap between policy and practice; schools need to intensify efforts to align their curriculum and instruction with the CCSS and restructure programs based on local results.

Contreras (2017) reported that the PARCC reading scores rose slightly throughout the state, but that the math scores remain stagnant. As a state, less than 20 percent of New Mexico students are proficient. New Mexico Education Secretary Christopher Ruszkowski stated there is still a lot of work to do, and that all schools have the choice to make improvements to meet the more rigorous standards needed for the 21st century (Contreras, 2017).

Hensley, Rankin, and Hosp (2017) point out that computer-based tests (CBT) can often cut time down, though the mode of assessing has an impact on the results. Thus, more research is needed to inform how technology affects common classroom assessments. Some advantages of CBTs in the classroom include reduction of printing, increased motivation of students, improved reporting accuracy, and immediate feedback to students and teachers. The inclusion of technology has provided immediate feedback to teachers on classroom struggles as well as individual skills. One study that showed a slight advantage in results for participants taking paper-based assessments also showed that over time the emotional state of participants was stable for the computer-based assessment (Sangmeister, 2017). Blackwell (2016) reported that in a recent study that looked at the NAEP online writing pilot most students were able to finish, but there appeared to be a socio-economic gap where average, low-performing, low-income, and minority students performed worse online, while high-performing students did better. Hensley et al. found that students consistently did better on paper-based tests (PBT), though the differences between CBT and PBT decreased as the grade level increased for students. All of these studies justify the need to better prepare students to successfully take online assessments. The problem of practice to be addressed in this study is the lack of information about how teachers use the new math software programs in their instruction and their perspectives on differences it has made in students' math learning at Sage Elementary School.

Rationale

As more students gain access to computers, integrating technology into mathematics has become a multifaceted issue for many elementary schools. Computers are being utilized for many of the following purposes: introducing topics, accessing current information, providing interventions, differentiating materials, teaching, practicing basic skills, typing, writing, coding, streamlining formative, summative, and state assessments, increasing motivation, offering home access, and providing personalized learning. Achieving meaningful and successful integration is a slow process influenced by many factors (Ertmer & Hruskocy, 1999).

A major change for many schools is the recent switch to computerized state assessments. For New Mexico, 99 percent of students took the PARCC online assessment in 2016 (NM First, 2016). Hensley et al. (2017) noted the mode of assessment can impact results, and that it was necessary to research how the shift to increase technology affects classroom assessments. There has been a transformation at the state level to require online testing. The local school is currently using technology for all the required district and state assessments. Yu (2013) noted there is a dire need to integrate technology programs into schools to enhance student achievement rather than to rely on the current technology trend of using drill, practice, and word processing. Similarly, Urbina and Polly (2017) noted that too often teachers are using technology only as an add-on activity with a focus on low-level computational tasks which is likely to have little effect. When technology is used effectively and supports higher-order thinking, it can positively affect students' math achievement (Urbina & Polly, 2017; Polly, 2016).

There has been a shift in education that assumes teachers need to utilize digital content to implement differentiated instruction that is rigorous and relevant to students. Technology is a focus of several national initiatives. Currently, there is so much new tech that it is difficult to evaluate and choose technology that is appropriate and relevant (Nelson, Fien, Doabler, & Clarke, 2016). The staff at Sage want to use technology that aligns with CCSS and reinforces current testing expectations. "To ignore the impact and value of technology would be a disservice to children who must adapt to its use" (Prosper, 2018, p.43). Although technology is being implemented to help support teaching and learning, research shows that elementary school teachers still struggle with integrating technology in meaningful ways (Polly, 2014; Connell & Abramovich, 2016).

Al-Mashaqbeh (2016) recommended the incorporation of technology as a strategy for teaching mathematics concepts and providing personalized education. Technology that provides formative assessments can be used to engage and adjust lessons based on learner thinking. This type of improved formative assessment and feedback loop can yield gains from one to two years in learning (Firn, 2016). Integrating online assessments can assist the teacher in monitoring students and make personalization more efficient.

Research shows that feedback is a beneficial feature of technology that can provide immediate corrections (Kanive, Nelson, Burns, & Ysseldyke, 2017; Schuetz, Biancarosa, & Goode, 2018) and is even better with teacher facilitation (Stacy et al, 2017) such as scaffolding (Kermani, 2017) and small group instruction (Kirikidis & Johnson, 2015). Technology should not replace the teacher, but assist the teacher in making the best decisions for each of the students. Stacy et al. (2017) found the tablet-based math practice was engaging for young children and that in general, student engagement was better with the presence of an adult to facilitate their online practice which could improve the "math-practice gap".

Lan and Ah-Teck (2015) confirmed previous findings that struggling students need more support online, so they do not get lost and lose focus. Lan and Ah-Tech also focused on the usefulness of technological tools and related factors to maintain student engagement for learning purposes. Students at Sage need practice and classroom times to learn and use digital tools and not encounter them for the first time during required assessments. Research supports the use of technology for higher student engagement (Stacy et al., 2017; Zheng et al., 2016) in addition to practicing more complex math skills (Urbina & Polly 2017; Polly, 2016).

Urbina and Polly (2017) noted in their study of elementary math technology integration there was limited use of technology that promoted higher-level thinking and deeper mathematical reasoning. Most technology was used for maintaining basic skills and providing additional practice to early finishers, prompting the question whether the limited use of math technology relates to teachers' lack of experience or beliefs and attitudes about technology (Urbina & Polly, 2017). The Reflex program is for providing enough practice to master fluency skills and does not allow students to continue to make the same errors. While reflex focuses on lower level skills, the TTM program is for integrating higher level skills and problem-solving and expects students to use different digital supports. Several studies found links between technology usage and comfort level of teachers (Kanive et al., 2017; Polly 2014; Hsu, 2016). This corroborates the need to collect data from teachers to analyze their level of preparedness for integrating technology. Project Tomorrow reported the number of teachers using digital content jumped 70 percent in three years with an 18 percent increase just in game-based learning (DreamBox, 2017).

Hawkins, Collins, Hernan, and Flowers (2017) suggested that teachers should monitor training, progress, and usage of computer-assisted instruction (CAI) for both math skills and fact fluency. Burns, Kanive, and DeGrande (2012) stated that additional research is needed to fully examine the potential of the computer-based math fluency programs. Both Reflex and TTM provide weekly monitoring reports that can be sent to teachers' email addresses, though current reports can be accessed at any time. Assessing instructional level for math to match student need should increase –task behavior, completion, and comprehension as it has been well documented for reading instruction (Burns, Ysseldyke, Nelson, & Kanive, 2015). Math facts should be harnessed since they have predictive value for math achievement (Nelson et al., 2016; Burns et al., 2015) and students who mastered fluency showed large gains in general achievement (Stickney, Sharp, & Kenyon, 2012).

Polly (2015) found students better able to utilize manipulatives and technology to create and explain math concepts more clearly when they were in classes where teachers received support in the Technology Integration in Mathematics professional development project. Using technology should enhance, not exclude the use of manipulatives or other materials during the math class. Sustained professional development was essential for supporting effective technology integration that led to gains in student math scores (Killion, 2016, Polly, 2015; Killion, 2015). Gains in math assessments have been linked with technology that supports higher-level thinking and problem-solving (Polly, 2016; NCTM, 2014). Effective technology integration should support student learning by including whatever mix of strategies is needed by individual students. Future studies should examine how to use the technology to support student learning and whether technology-rich, cognitively demanding tasks help (Polly, 2014).Research has shown that technology can have positive effects on student achievement in mathematics (Polly, 2015).

There is a gap in practice with comparing what math technology programs should do and know what they actually do in the local setting**,** therefore this study aimed to fill this gap by providing information about how teachers are using the new math software programs and what perceived differences there are. The purpose of the study is to understand how teachers are using the new math software programs and their perspectives on differences they notice in students' math learning and online assessment after using the program. No information has been used to look at how teachers have set up, activated, and implemented the math technology programs. Detailed descriptions of changes in practice and assessments while implementing these programs was documented. The technology programs that teachers provided feedback on for this study were Reflex Math and Think Through Math (TTM). TTM has adaptive features that can provide individualized settings and curriculum for remediation and extension in math as well as individual access to an online teacher resource during guided practice. Reflex has different fact mastery paths with adaptive settings for speed.

Definition of Terms

This section is to define terms and abbreviations that are particular to this study. The common terms of this study are as follows:

Every Student Succeeds Act (ESSA:) A federal law governing K-12 education in the United States that was passed in December 2015 (NM First, 2016).

Common Core State Standards (CCSS:) A set of high-quality academic standards in mathematics created to ensure students graduate from high school with the skills and knowledge needed for success in college, careers, and life. These learning goals outline what a student should know and be able to do at the end of each grade (CCSSO & NGA Center, 2016).

Partnership for Assessment of Readiness for College and Careers (PARCC): A group of states that worked together to create a new rigorous computer-based assessment that incorporated writing and was aligned to CCSS (PARCC, Inc., 2016).

New Mexico Standards-Based Assessment (NMSBA): The state adopted assessment that changed from a paper format in 2014 to a computerized PARCC test in 2015.

Public Education Department (PED): The New Mexico Public Education Department (NM First, 2016).

Think Through Math (TTM): An adaptive online math program to help develop higher order thinking and problem-solving skills that prepare students for success on PARCC (TTM, n.d).

Imagine Math (IM): A newly adopted 2017 name change for the program previously known as Think Through Math as it was purchased by Imagine Learning, Inc.

Imagine Math Facts (IMF): A newly 2018 added feature to the Imagine Math program for fact fluency practice that was purchased from Big Brainz.com.

Blueprint: A 2018 preK-1st grade level program expansion added to the Imagine Math program and adopted from Reasoning Mind.

Technological Pedagogical Content Knowledge (TPACK): A framework based on the connections of pedagogical content knowledge, technological content knowledge, and technological pedagogical knowledge (Koehler, 2012).

Technological Knowledge (TK): Part of TPACK framework based on "knowledge of technological tools" (Koh, Chai, & Tsai, 2013, p.795).

Pedagogical Knowledge (PK): Part of TPACK framework based on "knowledge of teaching methods" (Koh, Chai, & Tsai, 2013, p.795).

Content Knowledge (CK): Part of TPACK framework based on "knowledge of subject matter" (Koh, Chai, & Tsai, 2013, p.795).

Pedagogical Content Knowledge (PCK): Part of TPACK framework based on "knowledge of teaching methods with respect to subject matter content" (Koh, Chai, &

Tsai, 2013, p.795).

Technological Content Knowledge (TCK): Part of TPACK framework based on "the knowledge of subject matter representation with technology" (Koh, Chai, & Tsai, 2013, p. 795).

Technological Pedagogical Knowledge (TPK): Part of TPACK framework based on "knowledge of using technology to implement different teaching methods" (Koh, Chai, & Tsai, 2013, p.795).

Computer-assisted Instruction(CAI): A curriculum supplement for improving math skills, including fact fluency (Hawkins, Collins, Hernan, & Flowers, 2017).

National Assessment of Educational Progress (NAEP): A national exam that is dubbed "the nation's report card" to monitor changes in performance (Sparks, 2018).

Significance of the Study

The permeation of technology in the elementary setting has increased exponentially, so it is essential that schools understand the implications of its use (Harper and Milman, 2016). Technology has made its way into teaching and assessment formats for the classroom, school, district, and state levels. This results in the necessity for schools educators to understand how to best utilize and integrate into specific content areas for teaching, differentiating, and assessing. This study should provide some insight for technology integration into the content area of elementary math. Teachers should use technology strategically for teaching math where the lessons are purposefully designed to enrich how students and teachers learn, experience, and communicate with mathematics (NCTM, 2015). There are two math software programs, TTM and Reflex Math, that are being implemented at the local school, and potentially expanded to other elementary schools in the district. There is a need to provide teachers effective support for integrating technology meaningfully into math (Urbina & Polly, 2017; Kiriakidis & Johnson, 2015). Teachers are more comfortable, confident, and able to solve minor problems when they were provided with sufficient training and continued support (Zheng et al., 2016).

With student math proficiency dropping on the new PARCC state online assessments that require writing about math, studying the incorporation of technology programs into math instruction would be a good place to start identifying how well the programs are meeting local expectations and if there are any issues during implementation. There has been little local research related to the integration of technology at the elementary level. This study gathered teacher perspectives and offer strategies for effectively implementing the two different types of computer-assisted instructional resources for mathematics currently in place in this elementary school. This study also helped document technological interventions and identify any observable changes in student performance.

Data analysis might provide details about the usage and success of the new programs as well as teacher input about the programs and their suggestions for improving the implementation and support of the programs. The process for implementation served as an instrument of social change by providing detailed information on the benefits and challenges of integrating these technology programs into mathematics at a local level and potentially help other elementary schools in the district and local area with a smoother transition of implementation and evaluating benefits. Improved efficiency and effectiveness of instruction occurred when teachers were provided with professional learning on technology integration (Killion, 2016). This study could contribute to the preparation of students and teachers using new online learning programs and assessments.

Research Questions

This illustrative case study examined the execution and effectiveness of the recently implemented technology programs that support math instruction and the state assessment. This study was conducted to look at the effectiveness of math technology in the classroom. Through interviews and observations, the research questions provided teacher insight that offered a broader perspective of the training, implementation, and usage of the new technology programs that impacted student online testing.

The research questions have been built around the seven components of the TPACK framework documenting the benefits and challenges of the technology as it is integrated into the classroom (Evans, Nino, Deater-Deckard & Chang, 2015) as well as the TPACK goals of identifying effort and expertise while keeping a focus on content and pedagogy(Sobel & Grotti, 2013; Koehler, 2012). The first question gathering information on teacher perceptions and experiences should illuminate which of the three basic knowledge components of technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) from TPACK that the teachers perceive they are doing well and which are struggles. The second question relates to identifying how well professional development has prepared the teachers for utilizing the two technological components of technological content knowledge (TCK) and technological pedagogical knowledge (TPK) for implementation and continued support. And the final question relates to the influences of the pedagogical content knowledge (PCK) and the TPACK components with identification of the effects on student learning. The following questions guided this case study:

RQ1: What were the teachers' perceptions and experiences from integrating TTM & Reflex into the math curriculum to increase student achievement?

RQ2: What effort and expertise from professional development, supports, and challenges were clearly identified by setting up, activating, and implementing TTM & Reflex?

RQ3: How did the integration of TTM and Reflex influence the content and pedagogy as outlined in TPACK?

Review of the Literature

The literature for this review was found in the Walden University online library databases. Many articles were found through the Education Source and Thoreau databases. I used elementary math technology, TPACK, and computer assessment as key themes. Many studies stressed the importance of relevant professional development and continued support for technology implementation.

This literature review consists of four subsections relating to factors affecting the integration of technology for improving mathematics at the elementary level. The first section focuses on the TPACK framework that is guiding this project study. The second explores how math software programs have been implemented in the school setting. The third section looks at teacher preparation for integrating technology. The final section identifies potential barriers.

Conceptual Framework

This section of the literature review includes a collection of peer-reviewed articles and journals that relate to the usage of the TPACK framework. The National Council of Teachers of Mathematics (NCTM) stated the strategic use of technology strengthens mathematics teaching and learning when the decisions related to the use of technology keeps mathematics and not technology as the focus of instruction (NCTM.org, 2015). Therefore, this study was guided by the Technological Pedagogical Content Knowledge (TPACK) framework because it provided a strategic guideline for keeping the focus on the content and pedagogy (Koehler, 2012). This framework can also help with identifying and evaluating the benefits and challenges of the technology as it is integrated into the classroom (Evans et al., 2015). TPACK goals include clearly identifying the effort and expertise to set up, activate, and implement a technology program effectively (Sobel & Grotti, 2013). The technology programs being used provide an individualized learning experience that allows for self-pacing in the content, speed, and amount of repetition needed.

With technology support, students can reach mastery at their own pace and increase their perseverance through prolonged use. Self-efficacy is one component of a student's attitude which affects achievement motivation (Unfried, Faber, Stanhope, & Wiebe, 2015). Repeated success from effective integration of technology can improve student self-efficacy, extinguish the fear arousal that causes them to give up, and improve overall achievement. The TPACK framework should help provide clarity for analyzing the teachers' perceptions and experiences with integrating technology. By using the TPACK framework to design interview questions, the researcher can collect details about the benefits and challenges of implementing math technology. This provided information about the extent of knowledge the teachers have about the integration of technology, pedagogy, and content.

Koehler, Mishra, and Cain (2013)explain the seven components of TPACK and how it extends Shulman's (1986) idea of Pedagogical Content Knowledge. The first is the content knowledge (CK) that teachers have including concepts, theories, and ideas. Next, is the pedagogical knowledge (PK) where teachers know about the processes and practices of teaching and learning. Third is technology knowledge (TK) which includes the teachers' ability to adjust to changes in technology and identify pertinent technological information that can help students' learning. Fourth is the pedagogical content knowledge (PCK) where there is pedagogy that relates to specific content and links to curriculum and assessment. Fifth is the technological content knowledge (TCK) where teachers need to understand how the subject matter can be changed with particular technology. Technological pedagogical knowledge (TPK) is looking at the changes in teaching and learning from using technology. Finally, there is the technological pedagogical content knowledge (TPACK) which combines the interactions among all the individual components. Sobel &Grotti, (2013) provide an overview of the TPACK framework including its history, uses and concrete examples as well as the importance of combining the three components of technology, content, and pedagogy.

The TPACK framework guided the research questions by providing areas to focus on with the TPACK goals. This includes looking at how the integration of TTM and Reflex influenced the content and pedagogy as well as identifying the effort and expertise from setting up, activating, and implementing the programs. The TPACK framework shows how is important it is to describe teaching practices that incorporate technology (Muir, Callingham, & Beswick, 2016). Learning how to use technology to teach content is different from learning about technology "Integration efforts should be creatively designed or structured for particular subject matter ideas in specific classroom contexts" (Koehler & Mishra,2009, p. 14).This TPACK study should provide descriptions of how technology-related professional knowledge is currently being implemented. In turn, the analysis should provide better techniques for describing the types and depth of knowledge for the professional development that the local teachers need.

Review of Broader Problem

This review provided an overview of topics related to the problem. "It is critical to understand whether and how much teachers are using the technology with which they have access" (Blackwell, Lauricella, & Wartella, 2014, p. 89). This includes a strategies section on how technology has been implemented in the elementary math setting, a look at teacher preparation for integrating technology, and identification and summary of potential barriers. A current review is essential to understand the implications of technology integration in the classroom (Harper & Milman, 2016).

The literature for this review was found in the Walden University online library databases. Many articles were found through the Education Source and Thoreau databases. I used elementary math technology, TPACK, and computer assessment as key themes. Most searches included a mixture of the following words: elementary, primary, educational, computers, technology, meta-analysis, iPads, one-to-one, digital, assessment, PARCC, integration, software, math, mathematics, TPACK, barriers, professional development, implementation, attitudes, fact fluency, achievement, individualization, and problem solving. Many studies stressed the importance of relevant professional development and continued support for technology implementation.

Strategies for Technology Integration

This section explores how math software programs have been implemented in the school setting and relate to factors affecting the integration of technology for improving mathematics including incorporating fact fluency, individualization, math achievement, math communication skills, and attitudes at the elementary level. The use of technology as a strategy to teach and learn is a major challenge where teachers need to understand computer concepts and emerging technology (Yu, 2013). Technology has provided virtual manipulatives and other objects that can create a very different environment, so it is essential to ensure the tools and questions are appropriate for the students' developmental level (Connell & Abramovich, 2016; Kermani, 2017).

Fluency practice. One common theme found through several studies indicated the importance of making time for fluency practice. Increasing fact fluency has been an area that shows many correlations with math achievement and can make a great impact for elementary students (Stacy et al., 2017; Nelson, Parker, & Zaslofsky, 2016; Ravenel, Lambeth, & Spires, 2014; Stickney et al., 2012). It is important for all the grade levels to find time to incorporate fact fluency practice. Although there is evidence for the inclusion of fluency practice across all grade levels, one study suggested the largest impact was made on the younger students (Nelsonet al., 2016). This means it is essential for the younger grades to have a routine built in for the Reflex fluency practice.

Online methods for increasing fact fluency has had mixed results with studies. Some studies have shown online programs to have a positive influence on fact mastery (Stacy et al., 2017; Musti-Rao & Plati, 2015; Burns et al.,2012; Stickney et al., 2012), while other studies have shown no significant difference by using technology for support over another method (Ravenel et al., 2014; Carr, 2012). Despite mixed results, most studies have found a positive effect on the engagement and motivation of students with computer programs for increasing fluency (Ravenel et al., 2014; Hawkins et al., 2017; Musti-Rao & Plati, 2015; Stacy et al., 2017) which could increase effort. A recent study showed students using computer-based intervention had higher retention of facts (Kanive, Nelson, Burns, &Ysseldyke, 2017). It is likely the immediate individual corrective feedback that the computer program provided was beneficial.

Unlike reading, there is no general call for students to practice math on their own. Rather, math practice is generally confined to school assignments. It is also difficult to provide guidance at the appropriate level with a positive context and motivation. Apps can alleviate this problem by providing pre-determined practice problems delivered in a playful format with instant feedback (Stacy et al., 2017; Kanive et al., 2017). Tablet-based practice was found to be engaging (Hilton, 2016) for all elementary students regardless of setting or age and improved with the presence of a caring adult (Stacy et al., 2017). Stacy et al. recommended tablets and math apps as a feasible way to deliver the much-needed math practice to help reduce their coined phrase "math-practice gap**".** Computer-assisted interventions can be beneficial to math competence (Musti-Rao & Plati, 2015; Kanive et al., 2017).

Research indicates that math facts may retain predictive value for math proficiency. Although many students did not reach the grade-level recommendations, students who did reach the recommendations achieved superior gains in math (Nelson, Parker, & Zaslofsky, 2013). Although low achieving and at-risk students took longer to learn automaticity, they also had large gains on their math assessments (Stickney, Sharp, & Kenyon, 2012; Burns, Kanive, & DeGrande, 2012). Ravenel et al. (2014) commented that the lack of knowledge of math facts at the elementary level negatively affects students' educational performance in later years. Another practical suggestion is to spread consistent online technology usage with many sessions over time (Korkofingas & Macri's, 2013; Carr, 2012). Regularity is more important than total time. This was an important point for teachers to recognize while implementing Reflex and identify if it is not being utilized. Also, it is suggested to have computer fluency practice accessible at home to increase availability and success (Haelermans & Ghysels, 2017; Carr, 2012). It was beneficial to find out if the at home accessibility is used. All of these studies recommend the use of fluency interventions with individualized settings and practice to maximize growth (Musti-Rao & Plati, 2015; Kanive et al., 2017; Stacy et al., 2017). The Reflex fluency program has some individualized settings that should be utilized by teachers.

In 2017, Hawkins, Collins, Hernan, and Flowers wrote an implementation guide for using computer-assisted instruction (CAI) to help build math fact fluency. CAI for fluency should provide ample practice, give immediate feedback, present appropriate pacing, include engaging games and supply progress monitoring reports This guide also provides resources and recommendations for fluency implementation like finding consistent time during the first or last 10 minutes of the day and progress monitoring every two to four weeks depending on individual goals. The Reflex program meets all of these suggestions, but providing regular time intervals and monitoring progress reports were up to the teachers.

Research shows that online programs can increase engagement and motivation for practicing math facts (Ravenel et al., 2014; Stacy et al., 2017). Musti-Rao and Plati (2015) recommended that technology should not only be used for reinforcing math fact fluency but that teachers should use technology to supplement evidence-based, core instruction as well as continue studies on the effects technology has on complex and higher-order math skills. Burns et al. (2015) also see improving fluency as a stepping stone that provides access to more complex and abstract math skills.

Personalized education. CAI should still provide ample practice, give immediate feedback, present appropriate pacing, include engaging games, and supply progress monitoring reports for supporting specific math content (Hawkins et al., 2017). Another element that should be utilized in CAI for content is personalized education. Personalized education in technology can provide individual support and learning to maximize growth. Differentiation and individualized education are other terms that overlap with the same goals as personalized education. The duration and content for online learning should vary for individual students providing them opportunities to pursue personal interests and access their individual styles and needs (Prosper, 2018). Prosper also points out that technology should teach digital skills using content rather than the other way around because students can use technology to demonstrate their knowledge and access more diverse information. Differentiation is beneficial both for fact fluency practice (Burns et al., 2014) as well as for content.

Research recommends incorporating technology to assist in teaching math concepts and provide personalized education (Al-Mashaqbeh, 2016). Similarly, other studies have identified individualized CAI in math as a factor that helps students achieve higher levels of competency (Haelermans & Ghysels, 2017; Barajas, Álvarez, Mendoza, & Oviendo, 2015; Suppes, Holland, Hu, & Vu, 2013). Utah State University Department of Psychology found students using Think Through Math (TTM) with individualized support, the same program being implemented at Sage Elementary, more likely to be proficient on the state assessment (USU, 2016).

It is beneficial for teachers to be trained well-enough to utilize the personalized features that are available on the TTM program. Haelermans and Ghysels (2017) found individualization of exercises as a way to improve numeracy performance and make digital practice tools effective. Research shows that features of individualized learning like self-pacing, immediate feedback and breaking down complex processes are even more beneficial to struggling students (Zhang, Trussell, Gallegos, & Asam, 2015; Suppes et al., 2013). Using technology to personalize education for students often adjusted the role of the teacher. The teacher needed to manage all the students and their activities, troubleshoot a variety of problems and serve as a motivator of students to work regularly and carefully (Suppes et al., 2013).

The teachers should teach the students how to use the individualized tutoring support that the program provides. Finding out which teachers were utilizing the personalized features was informative. More in-depth follow-up also identified the extent to which each part of the individualized features was employed. Truly embedded formative assessment is most powerful when data is analyzed in real time, and feedback is provided (Firn, 2016).TTM has an online instant help and feedback feature that provides two different visual models followed by access to an online teacher, but teachers need to train students how to access this personalized feature. This could be an area that needs great improvement at Sage.

Communication. Using technology to communicate about math has been an area of concern that can be investigated in this study. Increasing writing about math and math processes can be a beneficial strategy when it is well-monitored. The TTM program recommends the use of a writing journal and format for solving math problems, but it is not required. This study should identify how and if writing is being developed in regards to the TTM usage. This should help clarify teachers' needs. The way writing, mathematics, and digital technologies influence student communication of mathematical ideas is under-researched (Freeman, Higgins, & Horney, 2016). Freeman et al. (2016) provided several important points for consideration when trying to improve math achievement and communication. When students wrote notes that could be assessed for correctness, their answers were primarily accurate. Different writing technologies influence the type of writing students use when communicating about their math process, so it is important to teach students to visualize math concepts and express them in multiple ways. Writing about math ideas encouraged dialogue with other students in a non-threatening environment and in turn, increased active thinking. Finally, writing about math is beneficial, but only when it is monitored closely with guidance for improvement (Freeman et al., 2016).

Another strategy that could help with the implementation of technology is peer tutoring. Yang, Chang, Cheng, and Chan (2016) found using technology with peer tutoring interactions a beneficial strategy for integrating technology to improve students' math communication abilities during a semester study of 51 second-grade students. Students' math creations went from difficulty with drawing at the beginning of the study to more developed representations with clearer explanations. Yang et al. noticed that for this strategy it is essential for teachers to make immediate corrections to students' work when identifying learning problems that could spread. This technology strategy could help improve the three components of math communication: expressing their math concept, understanding of others' math equations, and comprehending others' math thought. CAI can be used as a means to catch up on learning outcomes (De Witte, Haelermans, & Rogge, 2015).

Student attitude and motivation. Math achievement can be impacted by many factors of student attitude such as math anxiety, interest, confidence, motivation, and persistence. These are influential factors to consider while implementing technology.

Harris, Al-Bataineh, and Al-Bataineh (2016) suggested that one-to-one technology may be the catalyst for student achievement and motivation to attend. Increasing interest and confidence in math is malleable and depends on the yearly experiences, so long-term support and interventions should begin in early elementary school (Ganley & Lubienski, 2016). The use of regular technology for math at Sage Elementary is just beginning in second grade. It was helpful to identify how much and when technology is used for math. Ganley and Lubienski (2016) also raised questions about early gender differences in math interests being a factor in later academic disparities and suggested that math interventions for girls begin early with special attention given to math confidence.

To have students more effectively use problem-solving strategies, it is important to help them lessen their anxiety when they are engaging in mathematical thinking (Ramirez, Chang, Maloney, Levine, & Beilock, 2015). The advanced problem-solving strategies of decomposition and retrieval place depend heavily on working memory. Ramirez et al. (2015) also noted that children's ability to improve math skills relies on their comfort level with math and willingness to use cognitively demanding strategies. This is another reason why it was important to identify if students are using math journals during TTM. Improving fluency skills allowed students working memory to be used for processing more complex skills (Burns et al., 2014).Decreasing the anxiety of students and increase motivation for automaticity of facts and problem solving with the Reflex and TTM programs could increase achievement results for students with a high interest in technology and playing games on the computer. Long (2013) found increased motivation and performance with the incorporation of hands-on activities in technology and engineering.

Medoff (2013) identified problems with adversity and attitude in mathematics, noting a single problem could throw a student off for an entire test and stated teaching a child to persist through a small problem should help build their ability to not give up during a truly difficult problem. This source implied familiarity with online math programs and tools could increase student resilience and decrease the anxiety that interferes with testing by increasing the variety of activities and supports available for students to persist through. Technology is highly engaging for students and could be used to increase math confidence which matters for predicting later performance (Ganley & Lubienski, 2016). TTM and Reflex can be used as early interventions to increase student independence, problem-solving, fact mastery and confidence. By the same means, attitude and motivation of teachers are influential factors. Blackwell, Lauricella and Wartella (2014) found that the strongest effects on technology use were teachers' attitudes toward technology and its ability to help children learn followed by teachers' confidence and support.

Teacher Preparation

Kolb (2017) noted that the greatest effect on learning occurs when technology is effectively integrated into planning and instruction. This means teachers need to have constructive professional development that meets their individual needs. Teacher preparation is essential for integrating technology including implementation guidelines, training, and monitoring. "Individual teachers are the key to successful use of technology integration" (Yu, 2013, p.5). Hechter and Vermette (2013) broke technology into two categories: instructional technologies which are for presenting and sharing by teachers and educational technologies which engage students to improve student learning.

Half of the 430 teachers in Hechter and Vermette's study listed lack of training as a major hurdle for integrating technology. According to the study, the first steps to improve effective technology integration included targeted Professional Development (PD) for teachers and professional learning communities that align with teachers' values. It was important to clarify if teachers felt they have received the right amount of professional development and follow up to support their integration of technology. If not, it was critical to identify what PD the teachers still need.

Chen and Herron (2014) concluded that it is necessary to consider teacher differences in professional development to maximize effectiveness. All the professional development in using TTM and Reflex at Sage has been a presentation format with a small time left for questions. This PD was an essential start since the software programs were new to all of the staff. It was insightful to find out if the method of current professional development provided has met the individualized needs of the staff.

Professional development is not always a formal presentation by a specialist. There are several methods that teachers indicated helped them with improving their technology skills. Teachers identified workshops as a good resource and the ability to observe more technology-savvy teachers and use them as resources (Yu, 2013). There are a couple of teachers at Sage who would be considered as tech-savvy resources. It was also beneficial to see if teachers were utilizing peers to help with integration, trouble-shooting, and support for the programs. Lack of professional development to support the integration of technology is often listed as one of the major barriers in many studies (Yu, 2013; Hsu, 2016). Other studies had boasted of success when appropriate training and support were provided for teachers (Killion, 2016; Polly, 2015).

Integration of math technology is not just using computers to provide additional skills practice to students who finish early (Urbina & Polly, 2017), but rather the inclusion of learner-centered pedagogy (Polly, 2014). Connell and Ambramovich (2016) provided a list of three pedagogical suggestions for elementary math teachers based on the writings of Zoltan Dienes's view of manipulatives in instruction. Teacher training for math methods and technology usage at the elementary level should include the following: (1) understand content well, (2) model teaching and learning with technology, and (3) use technology to confirm and explore, but not replace thinking. Since many teachers have not been trained in technology integration (Hsu, 2016; Yu, 2013) it was important to ensure that the professional development incorporates modeling to fill in these gaps for current teachers. Polly's (2014) study confirmed previous findings that teachers tended to use technology they were comfortable with so support needs to include opportunities for teachers to use new technologies.

Since research shows that teacher facilitation and scaffolding are critical components (Kermani, 2017; Stacy et al., 2017) of successful technology integration, it was vital to observe and discover if teachers are receiving enough PD to implement these strategies. One of the greatest benefits of integrating technology is that it can be an efficient method for differentiating (Davis, 2018; Schuetz, et al., 2018; Musti-Rao &Plati, 2015) and providing immediate feedback (Kanive et al., 2017; Suppes et al., 2013). The immediate feedback technology provides is two-fold. It can be quick, corrective information for students providing guidance and hints for continued work or produce immediate feedback for teachers about students' performance (Polly, 2014). Immediate feedback for students means they don't have to wait for a teacher to grade their work before discovering a misperception. For a teacher, the feedback can allow them to provide corrective teaching more efficiently. Having access to this feedback means teachers needed to know how to find and use the information. It was instructive to establish how teachers are using reports, formative data, and other feedback and whether they have enough training to utilize the feedback and reports effectively. Kiriakidis and Johnson (2015) found common patterns with previous studies where participants integrated math software and used small group instruction to assist students and software provided instant feedback. Kiriakidis and Johnson concluded math teachers need a variety of PD that included teaching with interactive math software, using software assessments, using interactive educational software based on standards, and various teaching strategies for meeting needs of individuals.

Barriers

"Technology integration is evident in every aspect of our everyday life, and it needs to be integrated in every aspect of the teaching-learning process" (Yu, 2013, p.10). This section looks at barriers for integrating technology which are often made up of teachers' attitudes toward technology and limiting factors. Yu's (2013) study of teachers' beliefs with technology integration lists the limiting factors as availability of computers, software applications, lack of time, technical or administrative support, resources, and skill level. These same limitations were identified in a similar study by Hechter and Vermette (2013). Other barriers include knowledge and skills and attitudes (Delgado, Wardlow, McKnight, and O'Malley, 2015). It was informative to find out if the barriers of knowledge, skills, and attitude are factors for the teachers at Sage Elementary or if there are other barriers.

Resources. In one review of educational technology, 49 (40%) of the articles specified resources as the primary barrier of technology integration (Delgado et al., 2015). Resource limitations include lack of access to computer and software resources, lack of technical and administrative support, and time. The limitation of availability of computers often occurs in the elementary school at the lower grades where there is a poor ratio of students to computers (Yu, 2013). Sage Elementary had a reasonable ratio for the lower grades, but it is also true that the oldest computers get recycled down to the lowest grade levels and these computers may have the most issues. It was valuable to find out the primary teachers' perspectives on technology availability and what impact there is on integration of technology. Sage Elementary has one computer lab with a technical support person and one-to-one classroom laptops with wireless connections available for grades three through six. Kindergarten through second grade have access to the lab, a class set of laptops, and a set of iPads to share. According to the review, numerous studies reported a one-to-one environment can lead to higher scores in math, increased academic achievement, improved engagement and collaboration skills (Delgado et al., 2015).

The lack of appropriate and updated software is another common limitation (Yu, 2013). Yu mentioned that teachers are often left out of the selection process and are given software chosen by a representative or educational group. While this is true, the request for undertaking the TTM and Reflex programs came from the math teachers who wanted access to a program that was aligned to CCSS and the state online assessment in addition to a program that would support online fluency practice. Some software programs have presented students with independent practice skills without providing modeling and feedback to fix misconceptions (Nelson, Fien, Doabler, & Clarke, 2016). It was essential to find out teachers' perceptions of how well TTM and Reflex address misconceptions.

Teachers' lack of training and technical support is a common barrier (Hsu, 2016; Yu, 2013; Hetcher & Vermette, 2013). Administrative support has been shown at Sage through the purchase of TTM and Reflex to provide requested software to the math teachers. The principal set up a couple of optional professional development trainings throughout the year to support staff who are implementing the programs.

Time. Time is often a barrier to any new program because teachers try to add it in without other changes. Many teachers acknowledge the importance of technology, but do not have the extra time to teach the students how to use the computer (Yu, 2013). The common time barriers include time for teachers to learn to use the programs, time to plan technology integration and appropriate resources, time to teach the students how to use the technology, and time to teach a demanding curriculum (Hetcher & Vermette, 2013). Adding technology as an extra activity for students who finish often reflects low-level integration and is likely to have little impact on student learning (Urbina & Polly, 2017).

Urbina and Polly suggested more research on supporting teachers' integration of technology in a one-to-one environment with a focus on higher-order thinking skills.

Time is a precious commodity for teachers. For some classes, this means technology is only for the early finishers. Some teachers reported that using technology does not leave enough time to teach what is needed (Urbina & Polly, 2017). This is likely to be one of the biggest challenges for teachers in this study. The time to implement technology can be found if the new activities integrate or replace a previous activity instead of trying to just fit more into the same time interval. Long (2013) noted that the students' motivation and performance were higher in the classroom that incorporated real-life, hands-on application so he stated technology and engineering activities should not be added to the curriculum, but rather replace the rote learning and practice.

Beliefs. "Teachers beliefs are considered the best predictor of the way they will practice in their classroom, including technology integration' (Hsu, 2016, p.31). Yu (2013) concurred with this by stating that teachers who are comfortable using technology are more likely to integrate it into their classroom to benefit their students. Most of the teachers at Sage Elementary have a belief that technology can be beneficial, but it was enlightening to find out how the staff integrated technology into the subject of mathematics. Survey data from over 1,000 early childhood educators designated attitudes that value technology for assistance in children's learning had the strongest effect on technology use (Blackwell et al., 2014).

Implications

The purpose of this case study was to inform phenomena in the context of the local setting in which they occur (Creswell, 2012). There may be significance from this study for the local school district. The principal has expressed interest in the results of the study to review and share as software programs are being discussed and evaluated at a district level (Lynne, personal communication, 2018). The district is looking at homogenizing the purchase of online subject-specific software in the elementary school setting (Taylor, personal communication, 2018). Purchasing programs district-wide increases consistency between schools, provide similar support and comparisons, and facilitates the planning of relevant professional development.

Interviews and observations provided information about the many factors and challenges teachers feel affect the integration of technology into the math classroom. The study should also clarify the use of TPACK components while integrating math online programs. Many teachers struggle and need additional support with seeing the connection between technology, pedagogy, and standards (Urbina & Polly, 2017). Urbina and Polly stated that many teachers fail to implement all aspects of TPACK and that elementary mathematics teachers face hardships when technology barriers subsist. This study could illuminate areas of strength and related to the different contexts that make up TPACK. This would be beneficial to the educational leaders who plan professional development and make decisions regarding software choices.

Changes to the classroom setting could be impacted by findings from this study. This study could show how technology affected differentiation and personalized education in the local setting. Research shows differentiation and personalized instruction can be improved with technology (Harper & Milman, 2016). TCK and TPK have a stronger direct impact on TPACK, so it was useful to see how well teachers feel about their use of TCK and TPK and if there are ways to better support them. Although several components of TPACK are used by teachers, there is likely to be components to improve.

The implications of this study may inform similar elementary schools with ways to consider setting up, activating, and implementing math technology programs and professional development that align with the TPACK framework. The results of this project study could have a positive impact on the integration and implementation process of math technology for teachers at the elementary level.

Summary

This goal of this study is to understand how teachers are using the new math software programs and what perceived differences they notice in students' math learning and online assessment after using the program. The local goal is for teachers to integrate and use Reflex and TTM into the regular curriculum to help improve students' online assessment abilities. Section 1 showed there was no previous data collection or analysis of how and if the math software programs were being used. The study should clarify what factors are influencing the integration of software into the math curriculum. The nature of this study and the purpose were explained in section 1. Terms related to this study were also identified. This project study utilized the TPACK framework to gather information on the teachers' perceptions and experiences with these math programs including the identification of effort and expertise needed to set up, activate, and implement the programs. The details of the TPACK framework and relationship to the research questions are described. The body of literature that relates to this study was summarized in the sections strategies for technology integration, teacher preparation, and barriers. Finally, this section concluded with a short account of the implications particularly in the local area and similar communities. The challenges, benefits, and perceptions of integrating these programs into the regular math content and pedagogy were also analyzed. In the next section, I discussed the methodology for this project study. This discussion included details on the qualitative research design, the data collection process, the participants, the interview procedures, and data analysis results.

Section 2: The Methodology

Research Design and Approach

The nature of this study was a case study with a qualitative focus. Qualitative research is essential for providing rich, detailed information about the implementation process and observations related to student growth from using new online programs and how this relates to the TPACK framework which is a process of combining technology, pedagogy, and content for integration. TPACK consists of seven different components which may be used in varying degrees by the participants. The research questions stem from TPACK and focus on teachers' perspectives and experiences with integrating two math technology software programs. Miles and Huberman (1994) identified qualitative data gathered from intense, prolonged contact with a specific situation is powerful for discovery and exploring new areas. Results from this study should provide information related to the process of implementing technology into mathematics.

The data included interviews and observations to examine the success of these programs. The study included an analysis of teachers' perceptions regarding the new math technology programs to answer the question what are the teachers' perceptions of these programs, their effectiveness, and identify the support needed for set up, activation, and implementation. The teachers' views on using the new technology gave an in-depth perspective that illuminated the positive and negative aspects of implementing the new programs and provided suggestions for future use.

There are several choices for qualitative research methods. The choice of research shapes the information that the researcher is concerned with and informs the methods and techniques needed (Isaacs, 2014). The best choice for this qualitative study is a case study. The other choices of qualitative studies do not fit well with the problem or purpose of this study because this study is a small study at a specific site looking at technology integration using interviews and observations. Below is a brief explanation of why this project study does not converge with the criteria for the other choices of qualitative studies.

Dodgson (2017) defined grounded theory as a lengthy process of using constant comparison analysis with an end-product of creating a theory explaining the dynamics of the process. Constant comparison might be utilized as a coding strategy for this study, but not to create a theory. Dodgson also noted that grounded theory results showing relationships between concepts should be tested with further research. The researcher does not see how this study could identify a new theory, nor does the researcher wish to try to undertake such a large task. The researcher used elements of TPACK to help analyze the experiences of teachers who are integrating software into the math class, not try to develop a new theory.

An ethnographic study does not focus on individuals but on the patterns found within a culturally defined population where culture refers to shared values, beliefs, and practices (Dodgson, 2017). The researcher would make interpretations about these patterns. Ethnographies focus on human society and culture (Merriam & Tisdell, 2016), but this study does not meet the criteria as there is no particular culture that is being observed. There may be elements of a school climate and common educational beliefs, but that does not constitute a culture since any staff would have varying beliefs, values, and attitudes. Any patterns of behavior would be limited to teacher pedagogy and strategies. Since the population of teachers for this study represents a variety of cultures, this study fails to meet the basic premise of an ethnography.

A phenomenological study involves the investigation of everyday life experiences and how people interpret them (Lodico, Spaulding, & Voegtle, 2010). A phenomenological approach is ideal for investigating effective, emotional and intense experiences (Merriam & Tisdell, 2016). This approach is used to study an occurrence eliciting intensity and emotion that is experienced by one or more persons. There was no deep exploration into what it means to be an elementary math teacher who integrates technology. This study is not looking to gather data on emotions and intense experiences, but rather on the commonalities of challenges and successes experienced from integrating technology into the daily routines of the math classroom.

A narrative inquiry is where the researcher describes the lives of individuals, collects stories about the individuals, and writes narratives about their experiences (Creswell, 2012). The narrative research provides a unique insight to an experience through the story aspect with a beginning, middle, and end (Mohajan, 2018). This study involved interviews and observations as a narrative would, though it was to gather information from many different teachers about their experiences with integrating math pedagogy, content, and technology. Narrative research often involves additional types of data not used in this study like letters, diaries, newspaper articles, pictures, and web pages to provide a more comprehensive picture of the story (Lodico, Spaulding, & Voegtle, 2010). This study was not for story-telling or providing a unique perspective, but instead for analysis to support, analyze, and improve the integration of technology into mathematics. Given that this study was not sharing stories or describing the lives of individuals, it does not fit with the narrative inquiry.

This study was a qualitative case study which is defined as research that is looking for meaning, the researcher is the primary instrument of data collection and analysis, the process is inductive, and the results are richly descriptive (Merriam & Tisdell, 2016). A case study uses a bounded setting within its real-life context, and this study was limited to the teachers using specific math technology in the local school during their regular teaching routine. This study focused on the math classrooms within one school, and Check and Schutt (2012) noted that case studies take into account that qualitative research can focus on an organization, community, classroom, school, school system, a family, or individual that must be understood. Mohajan (2018) concurs stating that case studies are particularly useful in practice-oriented fields like education. This study should provide useful information that can be utilized the local school.

Thomas and Myers (2015) define a case study as differing themes and priorities with a great deal of study looking at the subject from various angles to approach the how and why. For qualitative studies, the researcher searched for themes to provide a better understanding of the group and process under study (Stebbins, 2001). This study focused on elementary math teachers who are using the Reflex and TTM online math programs. Data was gathered from interviews and observations, and much of the data was teachers self-reporting of behaviors. Semi-structured interviews allowed the researcher to gather information about the teachers' content, pedagogical, and technological practices. The case study provided a rich picture with analytical insights (Thomas & Myers, 2015). The analytic part of this case study was the analysis of data while looking through the TPACK lens.

The researcher did not collect any quantitative data. Since the program has not been required or consistently implemented and quantitative data was not utilized, program evaluation was not a great choice. Evaluation starts with some value and often is done on to measure the goal attainment of programs trying to solve a problem (Miller & Salkind, 2002). Reflex and TTM are not going to be evaluated directly, but rather look at the process of teachers integrating these programs for student improvement. It would be unfair to evaluate the program based solely on teacher interviews and observations. An expectation of consistency and quantitative data showing growth would be needed to make an effective evaluation. Despite the lack of quantitative data, there may be a short formative evaluation provided depending on results discovered. A formative evaluation might provide the principal or administration feedback identifying obstacles, unexpected discoveries, and recommendations for improving professional development or implementation support. Data gathered may be presented to leadership who want to have a broader perspective of some of the strengths, weaknesses, and issues encountered by staff while implementing the programs.

Despite the lack of quantitative data, the researcher collected and reported the basic demographics of the teacher participants and the local school. This was helpful for identifying if there are similarities or differences between teachers of varying years of experience.

Participants

This qualitative study is at a small, local, public elementary school where not all the teachers use all of the technology programs because they do not teach all the core subjects. This study focused on elementary math teachers who are using the Reflex and TTM online math programs which excluded some of the teachers at the school. There are teachers who do not meet both parameters of teaching math and utilizing the software programs. Teachers have been provided with access to the programs and optional professional development related to implementation. There has been no formal requirement for implementation guidelines or expectations, only that teachers try the program to see if it can help with math which is one of the current focus areas for the school. These results may not transfer to the larger population, though the researcher should take on the responsibility of making sure that findings are easily accessible to the community whether in paper form or presentation (Isaacs, 2014).

Participants were interviewed and observed on voluntarily. Participants were given a consent form with the details of their participation in the study as well as the commitment to confidentiality insuring that all information and findings had identifying features removed. Consent forms were sent through interschool mail or delivered in person depending on the preference of the teacher. A return envelope was provided for security. The questions for this study are best answered through interviews and observations to gain in-depth, rich information. This study included observations and interviews with about eight elementary school teachers who are incorporating technology programs. The smaller sample size allowed the researcher to delve into the experiences of each interviewee in a deep, meaningful manner.

This study used one of the non-probability sampling techniques which are often chosen for convenience or systematic criteria (Henry, 1990). Since the study is to look at the teachers' perceptions of the math technology programs, their effectiveness, and to identify the support needed for the implementation process, the population was limited to staff who have access to the programs. Purposive sampling was used since the researcher specifically sought these participants who have the experience under investigation (Rosenthal, 2016). Although purposive sampling is considered to rely on the researcher's knowledge and credibility, the researcher invited all staff who uses these programs to participate, and the researcher can confirm her target invitation list with the principal. These criteria limit the target population to about eight teachers and the principal. Isaacs (2014) reported an appropriate sample size was one that answers the research question. The researcher intends to gather information from all teachers who fit the criteria, demonstration saturation. In convenience sampling, the researcher selects participants who were willing and available (Creswell, 2012). Convenience sampling was also employed as a secondary feature since all volunteers from this purposeful sampling pool who were willing to participate were included in the study. Since the purpose of qualitative research is not to generalize, the small sample size should not be considered a limitation (Rosenthal, 2016). The researcher hoped all candidates would participate because they would like to contribute their experiences to the data pool and would value potential findings as it may apply to them.

In 2015, the researcher met with the principal and the current superintendant about beginning a doctoral program with intentions of researching at her local school. The administrators were supportive of this endeavor. In fall of 2016, at the advisement of her principal the researcher met with the Chief Academic Officer for the district to talk about any permission requirements for planning a future doctoral research project within the district at the local site. At that time, the researcher was told there were no required forms and that there should be no problem with a research study. The only exception would be if students were going to be interviewed or videotaped, there would be parental consent forms. The supervisory personnel have changed since then, but the current personnel are still supportive of the doctoral study. The current administration has begun financial support of staff willing to enroll in a master's program. During the summer of 2018, the researcher received a confirmation email (Appendix B) from the current Assistant Superintendent that there is still no required district form for a research study at the local school.

The researcher has taught for 13 years at the elementary school where the study took place. As a staff member, the researcher has access to all the teacher participants because they are co-workers. The researcher has shared her intentions of planning a research study during staff bonding activities in addition to informal staff meetings and lunches. The researcher has a close relationship with all the math teachers and has collaborated with most of the potential participants at some point in time. The principal has offered encouragement for the study, and as a sign of support, some co-workers have informally offered to participate when the time for data collection begins.

The researcher sent out an email invitation (Appendix C) as well as delivered hard copies through school mail since the researcher knows some staff members prefer not to communicate by email when given a choice. The email and letters will contain the same brief description of the study as the consent form plus my contact information. Emails are not always reliable as a means of contact due to the district filters and the tremendous amount of emails that staff is expected to read through. The researcher followed up with informal meetings and phone calls to explain the nature of the study and to clarify interest in participation.

Due to much time and many roles at the school, the researcher has maintained a trusting and professional relationship with the staff. The researcher has mentored several staff members, provided support for co-workers seeking their master degrees, served as a math coach and shared many resources related to math. The staff is aware of the researcher's intentions to get a doctorate and often ask about progress. The researcher has served as a support and advocate for materials related to math in the elementary school, and most of the staff knows that the doctorate relates to the TTM and Reflex programs. Regardless of a positive relationship with co-workers, the researcher made sure to follow the appropriate procedures required by Walden. The researcher intends on providing a relaxed, conversational style of interviewing in an environment where both parties feel safe as suggested by Isaacs (2014). The comfortable environment was vital to collecting the most honest and open information from participants.

Ethics protection can be broken into expectations for researcher conduct and procedures for regulatory compliance. Israel (2015) identified the ethical practices as avoiding harm, demonstrating respect, showing integrity, maintaining confidentiality, and seeking justice and the regulatory procedures as IRB approval, informed consent, confidentiality and beneficence. The researcher demonstrated these ethical behaviors for a trusting relationship and followed all required procedures. The researcher has received a certificate of completion for ethical expectations from the National Institute of Health. The researcher developed and use an informed consent form for participants to sign and keep a copy before data collection begins. Informed consent implies participants understand the nature of the research and their role in it and still voluntarily agree to participate (Israel, 2015). This consent (Appendix D) also provide details on the purpose, procedure, right to ask questions, assurance of anonymity, benefits, and the ability to withdraw from the study at any time. The researcher waited to receive approval from the Institutional Review Board (IRB) before conducting any data collection.

Face to face and focus group interviews occurred outside of contract time at the local school as agreed upon by the researcher and participants. A recorder and Google speech-to-text were used to give the researcher the ability to go back and confirm information, summarize the responses, and answer the research questions. The interviews were conducted in a comfortable setting with a conversational atmosphere to limit any stress placed on the participant. Overly intrusive interviews can cause anxiety and stress for participants (Hewitt, 2007). Aliases known only to the researcher and individual participant were used to ensure confidentiality. Observations were scheduled during the school day at the convenience of the participants.

Data Collection

Qualitative data is collected in the form of words and pictures instead of numbers (Bogdan & Biklen, 2007). Semi-structured teacher interviews and observations were conducted to assess the effectiveness of the TTM and Reflex programs on student achievement. The semi-structured interview has an initial set of questions that can be adjusted to the participant's responses so that the order can change in conjunction with follow-up questions or probes. The open-ended questions allowed for a large breadth of responses related to experiences with the integration of content, pedagogy, and technology and its effects on student achievement. This type of data supports a qualitative case study since there were a small number of participants at one elementary school. The researcher recorded and transcribed interviews as soon as possible. The researcher analyzed the data following the transcription and coding of the interviews. The researcher used the transcripts and coding to look for themes and identify and sort data. The same process was used for observational field notes. Additionally, the researcher looked for examples of strengths and weaknesses in the TTM and Reflex programs and training in addition to the teachers' ability to access the different components of TPACK.

As the main instrument in the case study, the researcher personally conducted the interviews and observations, transcribe the recordings, and code and analyze the data. The instruments for data collection included interview questions developed by the researcher, a recorder for interviews, and simple researcher-created observation sheets with a two-column format. One of the most common methods of qualitative data collection includes interviews (Isaacs, 2014). All the teachers who met the criteria for the research study were invited to participate, establishing a sufficiency of data collection and saturation.

Lodico, Spaulding, and Voegtle (2010) noted that semi-structured interviews are carefully planned and allow the researcher to change the order, omit, or vary questions depending on the interview. For this study, interviews were semi-structured in either a one-to-one or focus group format. The choice was given to participants to allow for individual preferences. Some staff preferred a personal interview to maximize confidentiality and meet their individual needs. Other staff chose a focus group interview because there is a significant amount of teaming and collaboration that occurs at this school, and some staff members were more comfortable with the team group format. One advantage of focus groups is they reveal parts of experiences that would not be available without group interaction because participants respond to each other with agreements and disagreements, asking questions and giving answers, and comparing their ideas (Morgan, 1997). The use of jokes, teasing, and disputes during group conversation provide the researcher with more insight into teachers' knowledge and attitudes (Isaacs, 2014).

The researcher created the interview questions keeping in mind the research questions, the TPACK framework, the discussion with concerns, and questions asked about math technology at the district software committee meeting as well as similar questions types that were developed in training assignments. Interviews were audio-taped with participant consent and began after approval by Walden's IRB Committee. Since the researcher is a teacher at the research site, the researcher has a professional, work-based relationship with the entire pool of participants. As a co-worker who follows the same regulations, attends the same PD and uses the programs, it is unlikely my position would influence their answers.

The interview questions (Appendix F) focused on the teachers' experiences and perspectives using TTM and Reflex while keeping the parts of the TPACK framework in mind. The interviews may last from thirty minutes to one hour depending on whether the participants are using only Reflex, TTM, or both. Focus groups could last up to one hour, depending on the size and conversation.

The aim of observations is not only to listen and write down what people say, but also to note subtle gestures, reactions, and bodily responses (Wasterfors, 2018). The observation paper included a header for listing the observational protocol, followed by a two-column section for field notes (Creswell, 2012). The observational protocol (Appendix G) listed the classroom setting, the observer, the role of the observer, the time, the date, length of the observation. The researcher took notes in a two-column format for taking notes. The first column was for descriptive data, and the second column was for reflections about themes, quotes, and personal experience. The descriptive data may include a sketch and descriptions of individuals, physical settings, events, and activities particularly focused on the inclusion of technology. The reflective notes may occur during the observation as well as after the observation. My role was as a non-participating observer.

The researcher found out possible times and dates to observe lessons that included TTM and Reflex. Observations were set up at the convenience of the participants. The researcher sent a reminder a couple of days before the observation. The researcher was truthful in clarifying that the observation was not evaluative, but rather a means to collect additional data for comparing and confirming findings from the interview data. There were no gifts or rewards for allowing the observation.

During interviews, the researcher used the computer speech-to-text, took notes on interview sheets, and used a hand recorder to avoid missing anything. The interviews were recorded and transcribed by the researcher as soon as possible. The researcher kept a binder with several pockets and tabs for each of the data sources. The sections were for signed consent forms, interview notes, field notes from observations, and the recorder. The researcher used color coding as one method of organization.

The researcher should have relatively easy access to the participants. The researcher works with all the participants daily and has lunch in a common area with several participants. Therefore, the researcher had some informal contact in a variety of ways. Access included personal contact, email, telephone, and interschool mailboxes. Different forms of contact and communication were preferred by the various staff members. The researcher often sees many of the candidates at school outside of contract hours as teachers plan, lead activities, and meet with colleagues.

For qualitative research, the researcher has a participatory role because the researcher gains access to participants in their environment and is considered the main instrument used to collect and analyze data (Clark & Veale, 2018). The researcher is a teacher at the site where the research was conducted. The researcher has taught at this school for thirteen years and was also a part-time math coach during one of those years. This experience minimized the time the researcher needs to spend with participants to develop a trusting relationship. Even though the researcher has a prior relationship, it is necessary for the researcher to follow the protocol of sending an invitation and following up with consent forms and assurances of confidentiality.

The researcher is also experienced with both TTM and Reflex, which offers the benefit of understanding details related to the programs, but also has the risks of interjecting personal bias. As with any study, maintaining a professional relationship with participants is important. It was essential for the researcher to listen and record responses and not interject comments. The researcher reviewed reflections and interview transcripts with a peer debrief to provide an outside perspective, free of bias. The peer reviewer was a college educator of mathematics who does not work in the local school or district.

Data Analysis

Data analysis can only begin until after IRB has approved the study, and some data has been collected. The researcher hopes to get approval for data collection near the beginning of the 2018-2019 school years. Castleberry and Nolan (2018) stated that qualitative analysis has five necessary steps: compiling, disassembling, reassembling, interpreting, and concluding. The researcher did not use a computer analysis program since there is likely to be only about eight participants, limiting the amount of total data. Compiling included transcribing the data, which was done as soon as possible, while the data from interviews and observations were fresh. Disassembling refers to the process of coding. Merriam and Tisdell (2016) recommended starting a qualitative analysis with the use of category construction, which is the same as identifying themes and patterns. This began with coding the transcribed interviews and observational field notes data in an attempt to find significant categories that surface. Category construction is an appropriate place to start for this study as a means to discover what patterns exist.

Coding should capture the main ideas or issues in the data (Clark & Veale, 2018). Data coding was started with the use of highlighters to mark text that might form groups and jotting code names in the margins. Initial codes may include descriptive codes, categories, and analytic codes. Merriam and Tisdell (2016) identify this sorting process as analytical or axial coding, which is not just descriptive but includes interpretation and reflection on meaning. Line by line coding is recommended as a starting technique with the next step being to refine this initial coding into a hierarchy making it more analytic (Gibbs, 2007).

Reassembling occurs when the groupings from each of the data sets were compared and merged into one master list of concepts created from all the data. This process of sorting the codes into categories helps generate themes based on discovered patterns (Clark & Veale, 2018). This compiled list served as a classification system reflecting the patterns which allowed the researcher to identify both commonalities and disparities among participants and their experiences. This is where the analyzing of themes is utilized and organized. Clark and Veale also recommend using a summary table to display the findings having columns for themes, the definition of themes, and documented evidence. This table supported the final concluding part of the analysis when the research questions are answered.

Coding was also used to identify statements that relate to challenges and successes from the integration of the programs and identify comments related to student achievement. There is also the possibility of looking for unique perspectives in the data by teaching experience (based on the number of years) and by teams since the school is broken into three groups: The Primary Team, Middle Team, and Upper Team.

The accuracy or credibility of findings for this study was determined through member checks and triangulation. Member checks and triangulation are recommended by Flick (2018) to ensure the accuracy of data and identify convergence and divergence in viewpoints. A variety of data sources, such as interviews and observations, was used to triangulate the data. Triangulation is a process used in qualitative studies to improve the accuracy of a study by using multiple methods from a variety of sources to compare findings for convergence or divergence (Namey & Trotter, 2015). Since the member checking process is used to confirm the accuracy of findings, participants reviewed their interview transcripts and interpretation of their responses for accuracy. The researcher provided individuals with transcripts and notes to review either by email or a paper copy, depending on their preference. After giving them time to review the materials, the researcher followed up with them by email to discuss the accuracy of the transcript and interpretation data. There were minimal changes. If any conflict were to occur, the researcher would have reminded the participant of their right to discontinue participation and have their data removed from the study. The researcher would also inform the IRB if a problem had arisen related to an unforeseen burden, ethical issue, or breach of confidentiality and follow up with requirements. Fortunately, there were no issues.

Merriam and Tisdell (2016) list peer review, reflexivity, adequate engagement in data collection, an audit trail, and rich, thick descriptions as other strategies for promoting validity and reliability. Having a worthy qualitative study implies the inclusion of adequate engagement in data collection, a detailed audit trail of the methods and procedures, and rich, thick descriptions. Since the researcher works at the school where the study takes place, it was important to use reflexivity to make sure to exercise enough critical reflection to avoid personal biases and assumptions that could affect the investigation. Flick (2018) pointed out that reflexivity is not a method, but a way of thinking that enables connections to be made.

Flick (2018) identified constant comparison as an important process for the researcher to use to look for deviant cases, which are the exceptions. Constant comparison is a coding technique to think about comparisons all the time to find distinguishing features about the text and its content (Gibbs, 2007). These exceptions should be used to revise explanations. Merriam and Tisdell (2016) identified using the discrepant case analysis where the researcher purposefully looks for data that might challenge the emerging findings. As a result, discrepant cases might surface in the research study. If there is no contrary data, it can increase the confidence in the initial findings. The researcher is looking for "the best fit" for patterns and conclusions where the weight of evidence is assessed (Merriam & Tisdell, 2016). It was important to identify discrepant cases along with alternative explanations if they arise.

Data Analysis Results

Once the consent forms were received by the researcher, interviews and observations were set up at the convenience of the participants. Some participants set up times through email, while others were set up in person. Overall, there were ten participants who returned consent forms throughout a week. One willing participant was not interviewed since the researcher went to set up an observation and discovered that the teacher was not using any of the programs that are part of the study. Three forms were returned in person, two participants gave oral consent and said they would return the form at the interview, and the remainder of the forms were received in the school mailbox.

There are several unforeseen changes that happened in the fall of 2018 that impacted the findings from this study. Starting in the fall of 2016, Imagine Math was available at Sage Elementary, beginning with third-grade students. Reflex was also available for 1st through 6th grade, though the first-grade teachers thought it was not appropriate for most of their students. These changes include the expansion of the Imagine Math program as it incorporated new resources and levels that incrementally became available throughout the fall of the 2018 school year. Initially, IM was designed beginning at the third-grade level but has adapted, adjusted, and incorporated features to make it accessible starting at Kindergarten, as well as offering a new fluency component called Imagine Math Facts. With the addition of IM Facts, the Reflex program was not continued after it expired in the late fall of 2018. Also, in the fall of 2018, there was a district-wide change to use Clever as a rostering program for all district online programs to minimize login time and the number of passwords students needed as well as improve monitoring and changes. There were several problems in the roll-out of Clever, which caused high frustration with staff as many online programs were not ready for the first six weeks.

There were a total of nine participants. Six of the participants chose to have individual interviews. The remaining three participants chose a focus group interview format as they felt they might have less to contribute since they had only been using the programs for less than six weeks with no prior training. The interviews were transcribed with a mix of speech-to-text, notes, and recordings. The transcripts were reviewed as they got transcribed, looking for patterns, trends, and themes. Coding was used to help capture the main ideas and generate themes based on discoveries (Clark & Veale, 2018).The coding of the transcripts began with highlighters and many reviews over the same transcripts. Words and phrases were highlighted in red, green, and yellow to identify potential themes and sort data. Red was used for negative associations of words, opinions, concerns, disadvantages, weaknesses, or missing components. Green was used for positive associations of words, opinions, benefits, advantages, and perceived strengths. Yellow was used for other comments, phrases, ideas, suggestions, and other descriptions. Then these topics were sorted to look for themes and common features as well as any discrepancies or contradictions. Themes surfaced logically around the set of interview questions and could be related to the research questions. As more transcripts were finished, they were coded and added to the data.

There were identifiable themes as well as words and ideas worth noting that appeared throughout different interviews and the focus group. Differences between the interviews and focus groups were noted. After transcription and coding, the transcriptions were shared with participants through Google sharing to confirm accuracy and researcher interpretation for member checking purposes. The shared invitation stated the transcript from the interview was being shared with the participant to confirm accuracy and interpretation and to provide the participant a chance to change, clarify, or adjust the information. The invitation also pointed out that the researcher had used color-coded highlighting to capture ideas for commonalities and analysis. The researcher also provided bulleted notes at the end of each question for potential themes and summarizing important data. Participants were given ten days to review the transcripts and interpretation and to identify any changes or concerns they had with the data. Observations were used to help triangulate data and confirmed much of the information discussed in the interviews. Flick (2018) recommended member checks and triangulation to ensure the accuracy of the data.

Findings

The common ideas found throughout the data included fidelity, differentiation, peer support, professional development types (and missing PD), the Clever platform, difficulties, reports, strengths & weaknesses, settings, time, comparisons between Reflex & IMF, and motivation. There were also many variations in how the programs were being implemented in classrooms as well as clear differences relative to the professional development provided, wanted, and needed. These topics could be sorted into the overarching themes of usage, strengths, concerns, and professional development. These data from these themes can help to answer the research questions.

One difference found throughout the interviews and observations was how the program was built into the math schedule. The quantity of time used for the programs ranged from providing time only to the early finishers during math class to providing a combination of three hours total time per week to work on the math programs. Older students were expected to pass two lessons on IM per week during the time provided. Younger students were expected to use the programs during designated times. Table 1 shows a summary of the time and usage of how the programs were utilized by the various math teachers. Programs were implemented and integrated in various ways. Reflex was used only during the beginning of the year due to the discontinuation of the program. As seen in Table 1, four teachers built time into the schedule for Reflex. Three of the participants mentioned the discontinuation of paper timed tests as it was replaced by Reflex. Imagine Math components were used as a motivation factor for early finishers in one class, as a station during math rotations for three participants, and as part of the routine class time for four participants. Participants who had used the program for more than one year had set aside more time for integration of the programs.

Table 1

Usage of Imagine Math and Reflex by Time and Type

Number of Participants	Program	Classroom
4	Imagine Math	Built into class schedule (1-3 hours/week);
2	Imagine Math	Choice for early finishers (minimal usage) or as As choice during math computer time
3FG	IM Blueprint K-1	Built into class schedule (0.5-1 hours/week)
3	IM Facts	Built into class schedule (about.5hr/week after IM)
3	IM Facts	Choice for early finishers as motivation
4	Reflex Math	Built into class time (15-40 minutes per week)
2	Reflex Math	Choice for early finishers

FG is written next to any of the focus group participants to identify differences between the focus group participants and individual interviewees. Responses for Reflex were for August through October until the program was replaced with IM Facts.

The focus group members all built time into their schedule and were happy to have an online math support program to use. Two of the members used the IM Blueprint program for a fifteen-minute rotation twice per week. The third member used the program about four times per week as a fifteen-minute rotation center during math. For the interviewees, the usage varied between teachers who used the program in previous years and teachers new to the program. The four who had prior experience and training built the program into their schedule anywhere from one to three hours per week (Table 1) and used it during math, and a couple of the teachers also used the IM and IM Facts programs during intervention time. The two who used IM for early finishers were new to the program, had no prior PD/training, and mentioned not knowing how to use the program. One of the teachers mentioned trying to use the program as a center but would be lucky to use it once per week, so the usage data was listed for early finisher.

Patterns

The researcher created a summary table to display findings and support the final concluding part of the analysis. As suggested by Clark and Veale (2018), the summary table has columns for the theme, the definition of theme, and evidence. Table 2 breaks the themes into usage, strengths, concerns, and PD. The definition of theme adds more clarification to the theme, and evidence of theme identifies the number of participants for each piece of evidence. The participant numbers with FG next to the number identify the focus group participants.

Table 2

Evidence of Themes

Theme	Definition of theme	Evidence (number of participants, FG)
Usage	Time & use of programs	Options of built into class schedule (4, 3FG)
		Attempting schedule, not consistent (1)
		As choice for early finishers, comp. lab (2)
		Fidelity of usage beneficial (2, 1FG)
Strengths	Positive attributes	Differentiation for IM (5, 2FG)
		Motivation with technology (4, 2FG)
		Liked by students (6, 3FG)
		Provides models (2)
		Set pathways/adjust level (3)
		Set weekly expectation (3)
		CCSS based, align with curriculum (4, 1FG)
		Rigorous/provides challenges (5, 2FG)
		Fill in curriculum gaps (2)
		User-friendly (4 Reflex)
		Perceived student benefit (4 Reflex)
		Easy for students to use (2)
		Support fact mastery (3 Reflex)
		Use to remediate, reteach, refresh (2)
		PARCC like questions (1)
		Build perseverance (1)
		Boost confidence (1)
		Practice success (1)
		Has changed planning (1, 1FG)
		Useful reports (2)
		Perceived student benefit IM (5, 2FG)
Concerns	Implementation struggles	Time (1, 1FG)
		Too language-based/difficult questions (4)
		Hard for low-ability students (6 IM)
		Too much like video game (4 IMF)
	Lack training	Need to use journal/writing (3)
		Have no prior training/PD (2, 3FG)
		Unfamiliar with program (2, 3FG)
		Don’t know what students are doing (1)
		Topic order not match plans (2, 1FG)
	Tech-related	Initial Clever related issue (6, 3FG)
		Technology issues mentioned (1, 3FG)
		Tech issues seen in observation (1, 3FG)
		Hard to use any tech device for young (3FG)

Table 2 (continued)

Evidence of Themes

Theme	Definition of theme	Evidence (number of participants, FG)
PD	Professional Development	Find/use/read/print reports (2, 3FG) No PD offered (2 IM, 5 IM Facts) PD conflicted with state testing PD (3FG) PD needs to be more individualized (2) Want PD (4, 3FG) PD came only from previous years (4) Better timing for PD (1) Use co-worker as a resource (5, 2FG) Need journal training/modeling (2) Set up individual pathway training (3) Using IM helps/live teacher (2

Note: IM is Imagine Math, IMF is Imagine Math Facts, and PD is professional development. There were nine total participants with six single interview participants and three focus group participants. These have been separated in the evidence column with an FG next to any of the focus group participants.

All three of the focus group members noted they were happy to finally have an online math program to use since most previous programs only helped with reading. As shown in Table 2, two of the focus group teachers said that IM was motivating, the students liked the program, and it provided differentiated instruction. All three focus group members mentioned various experiences that included both coordination and technical issues for students. Some students have trouble with clicking and dragging items and have to repeat the activity due to using tools, not comprehension. This problem seemed to be unique to the focus group teachers. This could be attributed to the lack of math tool experience of the younger students, the older laptops and iPads being used, or some other reason. The inability to use online math tools was one of the concerns that led to this study. Other experiences included technology issues where the students were kicked out of the program, or the program freezes up, and the device had to be restarted. One teacher mentioned she felt the problem was due to the older computers and iPads that were used for the younger students. Two members mentioned seeing some data that showed students' strengths, weaknesses and topics mastered and that the reports would be helpful. All three commented that they needed to find how to access and read the reports and would like to have more training to find out about the different report features to improve their ability to use the program and find the reports that provide specific information about strengths, weaknesses, and progress toward standards. The most constant concern with the focus group members was the lack of training/knowledge, which came up eighteen different times throughout the interview process.

The other six interviewees felt the only technological hindrance was the initial access problems with the start-up of Clever as a platform. One teacher mentioned technology as a minor issue. Of the six individual interviewees, four of them had PD in prior years and had been using the programs for multiple years. These participants felt confidence with prior PD for using the programs, and had much more specific requests for PD training needs, The other two participants were new to the IM program in October, received no training and had no previous experience. They both commented on the students' ease of logging in without problems, and that they were unfamiliar with the details of the programs, knowing the order of topics, and accessing reports. If topics seemed frustrating, they might tell the student to move to the facts games. These teachers wanted PD but had no specific requests as they did not know what features were available. Five teachers found a perceived benefit for students if they were at the right level and motivated. Four teachers identified Reflex as helping students learn facts.

Table 3

Quantity of Times for Theme

Theme		Total Times Mentioned (by individuals, by FG)
Usage	Centers/Regular schedule	6, 3FG
	Fidelity	5, 2FG
	Changed my planning	7, 2FG
Strengths:	Positive feelings comment	17, 19FG
	Positive content-related features	38, 20FG
	(i.e., standards, differentiation, modeling)	
	Liked by students/Motivating	13, 7FG
	IM perceived benefit to students	14, 3FG
	Reflex perceived benefit to students	4, 0FG
	Ease of use	10, 3FG
Concerns:	Total times tech-issue mentioned	1, 15FG
	Tech-Clever/Access	5, 3FG
	Negative feeling comment	4 (3 for IMF), 0FG
	Negative content concerns	14, 1FG
	(i.e. too hard, language-based, difficult)	
	Lack of training/familiarity/experience	10, 15FG
Professional Development general comment		7, 0FG
	Unable to attend PD/conflict	0, 3FG
	PD was Met	4, 0FG
	PD needed/wanted	5, 8FG
	Specific training topic requested	7, 3FG

Note: IMF is for Imagine Math Facts. FG is for focus group members.

Table 3 above provides the number of times that theme topics were discussed in the interviews. The data shows a large number of positive comments and features with 36 positive feelings, 58 positive comments about program features, 20 comments about students' liking the program, and 13comments on ease of using program. This outweighs the four negative feelings (three related to IM Facts looking more like a video game with not enough focus on facts), and the 15 negative content concerns mainly focused on high rigor and a need for better leveling in the program. Over half of the negative comments regarding levels could be addressed with PD on setting up individual pathways, changing levels, using different helps & online teachers, and incorporating a journal. There were 25 comments on not having enough training yet, 13 comments on wanting PD, and ten requests for specific PD. Only four members felt they had enough PD to feel comfortable with the program, though a couple of these members had specific requests for PD. Their knowledge of the programs allowed them to articulate what they specifically need for additional training. This data showed there was a desire for more PD training. There were 14 comments about perceived benefit from IM, but some of them were conditional. Some conditions for benefit included motivation, correct level, and fidelity of usage.

The final data table shows compiled data from the observations. The table is broken into teacher numbers and a list of observation findings. Table 4 provides a summary of how the programs were used in the classroom. Observations included computer usage time, students' ability to login, badge cards for login efficiency, tech issues, assistance required, adult support, the number of students using writing tools, and student engagement. The data from this table confirmed that the majority of the technical issues were in the focus group members' classrooms. The data shows that most of the teachers have built time into the math class to use the programs. The data also shows that older students are more capable of using some of the program's required online math tools without assistance. The researcher was not able to identify how many students were using the optional online math tools, glossary, online help(s), or online teacher support during the observation.

Table 4

Observations of how programs were used in classroom

Teacher	Observation findings
T1	All students able to login quickly & use online tools (math time) 4 of 6 students used writing tools (paper or white board) 2 of 6 students needed regular assistance, 1 student distracted
T2	All students able to login quickly & use online tools (math time) 5 students already completed online lesson 4 of 7 students used writing tools (paper or white board) 2 of 7 students asked for a quick assistance, 2 of 7 distracted for short time
T3	Only 4 students finished & were able to use programs (early finishers) All students able to login quickly (badge cards) & use online tools No students using writing tools, All students fully engaged
T4	All students able to login quickly & use online tools (math time) Over half of students used writing tools (paper or white board) 3 sets of peer collaboration, 1 question for teacher, 1 student distracted
T5-FG	All students able to login quickly (badge cards) & minor tech problems Groups rotate through stations with adult support (math centers) 1 peer support, 1 adult support No writing tools used, All students engaged
T6-FG	Most able to login quickly (badge cards) & use online tools, 1 tech issue 3 groups on computers & rotate into teacher station (math centers) A couple students get paper IA supporting class & 3 students, 3 students distracted
T7-FG	All students able to login quickly (badge cards) & 3 minor tech issues Groups rotate through stations with adult support (math centers) 1 peer support, 2 adult support No writing tools used, All students engaged
T8	All students able to login quickly & use online tools 1 peer support, teacher move about & provide adult support (math time) All of class but 3 use writing tools used All students engaged
T9	Most able to login quickly (badge cards) & use online tools, 1 tech issue Groups rotate through stations with adult support (center) 1 peer support, 1 adult support No writing tools used, All students engaged

Note: There were nine observations for a 15-20 minute time to observe students' ability to login, look at how programs were integrated, notice technical problems, notice amount/type of writing, look at support, and monitor engagement. FG identifies the focus group members.

All three members of the focus group mentioned not being able to attend the PD due to other PD related to state-required testing. The programs were setup through Clever so the teachers did not have any set up, but just let the kids try the program without knowing much about it. All the focus group members mentioned several times throughout the interview, their desire to have PD set up and given, so they can better understand and use the program and reports. One member mentioned not knowing if a student was repeating a lesson due to poor performance or lack of time where the student was bumped back to the beginning of the lesson because they didn't get enough of the lesson finished in the previous center time. The integration of IM has only had some influence on the TPACK content and pedagogy for the focus group members. One focus group member noted, "I don't think I've had enough exposure to it, but I did look at the guide, and I really think it's a really good program." Another member agreed. She went on to mention that the program was useful to provide an alternate way for children to learn because using multiple methods is beneficial, and some kids are used to technology. The third focus group member noted that it has already changed her lesson planning because she has been able to use the IM Blueprint program for centers in the classroom and that it has been helpful for some students who are a bit more active to be able to sit and focus and to help get through some of the curricula. Currently, the changes for these focus group members are limited to TPK by increasing math center times with the addition of technology and adding technology as an alternative method.

Similarly, two of the interviewees mentioned they did not receive any PD but felt they were able to use the programs because they were user-friendly. They also felt there were many items they lacked training for, such as alignment to curriculum, expectations, adjusting levels, and using reports. Four of the interviewees felt they received enough PD in prior years, and had a few requests for specific training such as journal usage, reports, and creating/assigning pathways. There was more use of TPACK features with the experienced members. This included the use of specialized features, assigning pathways, setting up routine times during math and intervention blocks, using the program for pre-teaching and remediation, setting goals, using rewards, collaborating with peers, and encouraging writing. The teachers new to the programs commented that they didn't have enough experience other than looking over students' shoulders. They were both working on trying to set up a more regular routine for integrating the programs. One was trying to use it on occasion during computer lab time. The other was trying to find a way to fit it into the math schedule, but not with regular success yet.

There are a variety of findings that relate to the research questions. There was sufficient data to help answer the first research question, what are the teachers' perceptions and experiences from integrating Imagine Math & Reflex into the math curriculum to increase student achievement? The overall perceptions and experiences from integrating Imagine Math and Reflex into the math curriculum were supportive as the participants were happy to have online programs to reinforce both content and fact practice for math. This is found in Table 3. In general, all participants had positive comments about using Imagine Math as it offered differentiation, PARCC like and CCSS online practice, high rigor, visual modeling, extensions for the higher students, practice for success, building of confidence & perseverance, opportunities for re-teaching, filling gaps, building math sense, practice answering wrong, and multiple pathways available for adjustment by topic and level.

Table 3 also showed a variety of concerns. The concerns with IM were similar for most participants and revolved around concerns for lower level and special education students beginning in grade 2 or higher. The program concerns for the lower level students were described as very language-based, difficult to read, too many missed questions increasing frustration level before level adjusting, limited access to help (only during guided practice), and very problematic if students were not assigned to lower/appropriate grade levels even with the preset leveling. There were many mixed comments about Reflex and the replacement of Reflex with Imagine Math Facts. The data shows the facts programs have only been used with second-grade students and higher although Nelson et al. (2016) suggested the largest impact can be made on the younger students. Four of the participants would like to get the Reflex program back. All participants felt that both programs were liked by students and increased engagement, similar to previous studies (Ravenel et al., 2014; Stacy et al., 2017).

All the participants who have used Reflex and Imagine Math Facts have noted that the IMF seems like a video game with many video gaming features. Five of the participants who are teaching 2nd grade and higher have identified the importance of having an online program for fact practice. One participant mentioned a connection between students who were using Reflex and improved math achievement. There was one concern brought up that it would be helpful to have an advanced level or activity on the facts program for students who are proficient with their facts. There was a general belief that the programs are helping with student achievement for various reasons. Four participants specifically identified fidelity of usage as a key element to successful usage and impact, and two others identify a dedicated amount of time given to the program to use it well.

Discrepancies

Those who teach second-grade students are happy to have a student-liked online program to provide facts practice and did not seem to have a preference between Imagine Math and Reflex. Neither has received training but noted the programs were set up and easy for the students to use even without PD. This discrepancy in a lack of preference could be related to several factors. It could relate to the detail that the programs are used for motivation and enrichment in one class for students who finish their math early or that the students choose which math technology program they want to use during centers. It could be because the teachers are not monitoring the program reports to monitor progress. Students are using the program for the first time and like the games. It also could relate to the focus of facts games for second-grade students to be on addition and subtraction. It would be difficult to identify the reason without further research.

The remainder of the participants who used both Reflex and Imagine Math Facts seem to prefer Reflex, identifying the program as better support for mastering facts. In contrast, they identify IMF as more of a gaming program where the students are focusing on completing the game and opening new levels rather than mastering facts. There were a few benefits noted for IMF, such as it could be more motivating for particular students, and there were some visual supports for fact practice. The preference of the other participants could also be a factor of familiarity since they had been using Reflex for a couple of years.

There were clear differences that showed up for the second research question, what effort and expertise from professional development, supports, and challenges can be clearly identified by setting up, activating, and implementing Imagine Math & Reflex? First, Imagine Math and Imagine Math Facts were set up by the district personnel through Clever and took several weeks to set up and run. Reflex was still set up by teachers, so it was available as soon as teachers chose their students from the data bank.

There was a range of perceptions related to professional development based on the program and when the program was started. For Reflex, four of the participants identified webinar PD as having been provided in previous years, and two participants identified the program as a teacher-friendly program where minimal PD was needed. The program was useable without PD. There was access for the teacher to see what students saw. The PD did clarify reports. As shown in Table 2, four of the participants identified a clear desire to get Reflex back. One participant mentioned beginning later and using IM less than usual not only because of Clever, but also to make the most of using Reflex for the limited time it was available. Four participants who used Reflex felt comfortable with using the program and the previous PD.

The most significant differences in professional development, supports, and challenges were found in the Imagine Math Program. Professional development was provided in past years with different methods. There was the option of professional development for Imagine Math at the beginning of the year, which was focused on teachers who were new to the program. The second-grade teachers did not attend as they did not know that the program would add second-grade in October. This means the second-grade teachers have not received any professional development for Imagine Math, and they both noted the program is challenging, and only higher students tend to choose to use it. This means their only current resource is peers, and that places a burden of time and availability.

Similarly, all the K-1 teachers lack PD for the Blueprint K-1 portion of Imagine Math. There was PD provided near the beginning of the year, but it conflicted with the istation PD, which has a required state test component, so all the teachers at this school did not get the PD they wanted. All three K-1 participants mentioned a desire to get information related to the program and reports available. They have requested a webinar or meeting where they can get some PD, but nothing has been scheduled yet. Luckily, the students' accounts were set up by the district, so those teachers have begun to use the program even without PD. Another participant mentioned several times in the interview how it would be essential to have a more differentiated level of PD because the generic PD is too general to meet the needs of teachers who have been using the program for different amounts of time. This comment confirms Chen and Herron's (2014) conclusion of considering teacher differences to maximize PD effectiveness.

The perception of set up and activation of Imagine Math for the current school year varied. Seven of the teachers mentioned difficulty with Clever, a new online rostering platform used to minimize student login time. There were many problems with Clever at the beginning of the year and a few problems with how classes were set up by grade-level and not necessarily by the teacher of record. The district has noted they will do better with rostering classes next year as they have a better understanding. There was no professional development provided for Clever. Since the district took over the setting up and activating of district programs, initial Clever set up was the biggest hindrance to the programs. Clever has been beneficial, as seen in observations by efficient login of students at all grade levels. In five of the classrooms, the researcher observed students using badges to login with the computer cameras activated. The researcher also observed a new student logging into her computer on her first day as she was rostered into all the programs and could login quickly.

There were some differences noticed in the data for the third research question, how has the integration of IM and Reflex influences the content and pedagogy as outlined in TPACK. There was a large range of influence on content and pedagogy and student learning, as outlined in TPACK from the integration of IM and Reflex. There were six participants who said the programs did not influence their content or pedagogy at all. One of these participants identified that she did not have enough PD, training, or time to delve into the IM program enough to look at the alignment or adjust pathways. She did mention that she did stop using paper timed tests with the Reflex program. Two other participants also identified the change from paper timed tests to the online program for fact practice. Although they did not see it, replacing time tests with an online alternative is a change of practice.

Of these six participants who identified the programs as having no influence, three of them built-in math computer time, and two of them use the math programs as a center activity during math stations. The rotation time in kindergarten provided an activity where the students could be fairly independent, allowing the teachers and volunteers to better focus on the other centers. This is only a small pedagogical influence on the types of activities used in math rotations. The researcher noticed in observations that students who had technical problems sometimes received help from their peers. The participants identified the benefits of using the program, despite the lack of professional development. Hsu (2016) identified teachers' lack of training and technical support as a common barrier. This barrier seems to be a factor at this site, though teachers are still using the programs.

One participant who has been using the IM program for three years mentioned several ways in which the integration of the IM program has influenced the content & pedagogy in her classroom. She used the program to review content, adjust levels to student needs for enrichment and remediation, provide reteaching opportunities, encourage perseverance, increase number sense, and adjust content to align with her content. Two other participants mentioned the same types of influences on a much smaller scale.

Quality

Several processes were utilized in the study to address the accuracy of the data. Since the researcher is the main instrument of data collection in a qualitative case study, Merriam (2009) identifies the importance of honesty by the researcher. After transcription and coding were completed, the researcher shared the transcriptions with individual participants through Google documents. Participants were given ten days to review the transcripts for accuracy and researcher interpretation and to identify any changes or concerns. This sharing of documents was to ensure internal validity for member checking purposes by confirming the accuracy of their responses as transcribed by the researcher and corroborating that their experiences were not misinterpreted. A peer debrief was also used to review the findings to help avoid biases and determine reasonableness. Flick (2018) recommended member checks and triangulation to ensure the accuracy of data. To make the findings more credible, triangulation was utilized by including observational data of participants using the math technology programs in the classroom setting. Observational data found in Table 4 confirmed much of the information discussed in the interviews. There was high engagement, the majority of technological problems occurred with the focus group participants' classrooms, students were able to login quickly, the majority of students were engaged, and the type of integration was confirmed. Namey and Trotter (2015) identified triangulation as an important process for improving the accuracy of a study by using a variety of sources to compare findings for convergence or divergence.

Summary

The nine teacher participants displayed different levels of understanding of the components of TPACK. Teacher 2 demonstrated levels of PCK as she spoke about using the Imagine Math program to add modeling as a means for some math concepts instead of just teaching the basic algorithm. Eight of the participants had a hold on TCK as they incorporated time that was specifically designated for the use of technology programs to practice math content, as shown in Table 1.The teachers understand the value of the programs as Teacher 6 noted it is important “to keep it consistent, to do it with fidelity because that’s when things like this work best” and Teacher 1 noted, “I’m watching them under my supervision do it [IM] with fidelity.”TPK was observed in six of the classrooms when students drew models to solve problems, talked with peers about math, and asked the teacher for support.

Overall, the data showed the teachers’ perceptions and experiences from integrating Imagine Math and Reflex were positive. Every participant had positive comments about having implemented the programs. The most common features recognized as strengths were the differentiation pieces, positive student opinions, and alignment with the CCSS. Davis (2018) identified technology integrations as a benefit because it provided an efficient method of differentiation. Teachers with more experience tended to integrate more regular time for the programs. The four participants who used the program for more than one hour per week are also experienced teachers who attended related PD for both programs beginning in 2016. It is essential to understand how much teachers are using available technology (Blackwell, Lauricella, & Wartella, 2014).Blackwell et al. also state it is important to invest enough time to provide support for teachers to integrate technology effectively.

Although peer assistance was found as one of the best supports, one challenge from implementing IM and Reflex also stood out. This common finding throughout the data was the need for more professional development, as shown in Table 2, with seven(of nine) participants wanting more PD and having requests for PD to be offered at different times and be more individualized. Table 3 shows how many times PD and lack of training came up in the interviews. This seems to coincide with research. Hsu (2016), Hechter and Vermette (2013), and Yu (2013) identified a lack of training and PD as a major barrier for integrating technology. Chen and Herron (2014) identified the necessity of differentiated PD to maximize effectiveness. Several participants demonstrated a need for further PD on the programs to have a more comprehensive integration of TPACK components. This is exhibited by the comments from Teacher 8 as she said, “one of the struggles that I've had with it is getting students into the right class or the right path,” and additional commenting on needing to teach herself more to use the program better. Teacher 2 has similar views saying, “we've got to figure out how to deal with the lower level students.” Teacher 5 concurred, commenting, “I think it would be so helpful once you get online and figure out what’s going on.” The data shows it would be beneficial to identify and provide appropriate level PD or training support to the staff at Sage Elementary. Research shows that success can be achieved when appropriate training and support were provided (Killion, 2016; Polly, 2015).

The integration of IM and Reflex had some influence on the content and pedagogy of TPACK. One teacher specifically identified changes in her teaching by utilizing the features of the IM program. Several teachers identified using the technology programs as one station of about four different stations that students rotated through supported math content. As shown in Table 4, the researcher observed adult support specifically for the technology rotation in two of the focus group members’ classrooms.

One of the interviewee's classrooms also used some adult support for one table. The researcher also observed non-teacher adult interactions with students to assist the students in using technology. A couple of participants mentioned eliminating the paper timed tests and replacing it with the online fact programs. Long (2013) stressed the importance of not adding more to the curriculum but replacing it.

Three of the participants were able to demonstrate integrating technology that indicated the multiple aspects of TPACK. Teacher 4 demonstrated the incorporation of all components of TPACK as she specifically used technology to modify the pathways on Imagine Math to level them individually for students. She set the content at various levels for pre-teaching, re-teaching, remediation, enrichment, and practice. She also used the reports. Teachers 1 and 2 also have begun to set alternate pathways for some students who are above and below grade level. Four other participants mentioned wanting more PD specifically to utilize the programs better, the way they were meant to be used. Several participants also mentioned wanting to understand better how to use the reports and online information available. TPK also includes the use of online electronic scores, which are available almost instantly (Evans et al., 2015). This desire for more PD demonstrates the interest of these participants to increase their ability to apply TPACK. As shown in Table 1, one participant mainly used the technology for students who finished their work early. Urbina (2017) identified adding technology as an extra for early finishers was a low-level technology usage that was likely to have minimal impact on learning, and this was often caused by teachers' lack of experience or knowledge of the technology.

Project Deliverable

Based on the results of this study, it would be logical to plan a set of differentiated professional development sessions based on the different needs and requests identified. A list of needs and requests related to PD could be organized and shared with the district leadership to identify the requests from one school as it is likely that the other schools in the district would have similar needs. Next, a basic three-day PD plan could be outlined and set up using a slide show format. Finally, some short guides giving basic processes could be written up to support the PD and to provide teachers with a quick refresher guide on the bigger components.

The first and beginning level would be basic introductory professional development for the five staff that have not had an opportunity to have professional development related to Imagine Math and Imagine Math Blueprint for K-1. This would provide the essential information on how to use the programs, what are the basic features of the programs, and utilizing reports. There would need to be a follow-up shortened PD to provide ongoing support and answer new questions based on their implementation needs. Since Clever is being used within the district to set up and roster all programs, the PD could eliminate the steps associated with setting up accounts and rostering students into classrooms.

There should also be a component of PD for the Imagine Math Facts component of IM if it is continued since none of the teachers had training on this feature of the program. This feature was added in the late fall after most of the PD for the year had been provided. Since students were rostered through Clever, teachers could assign time for students to try the program. There has been no training about how to best utilize the program, nor how to access and read reports related to usage and math fluency.

The differentiated sessions for staff that have been using the IM program should address the various concerns and supports that were discussed and listed in Table 3. These include the modeling of journals for problem solving, clarifying the process for finding, reading and using reports to maximize growth, discussing and modeling of how to increase the students' use of helps and live teacher supports, and demonstrating the process for setting up individualized lessons and pathways with time provided for teachers to use this process. Each of these components could be provided during a different time block so that the teachers could come to just the component they need rather than having to attend the whole session. There should also be hand-out packets to give the staff that can be used as a resource.

Section 3: The Project

Introduction

The proposed project is a three-day professional development plan based on the needs identified in data analysis. The researcher will create a power point presentation with notes that presents the basic materials for teachers who are new to the program. The power point will also address the specific training requests that were identified by teachers who were familiar with the programs. These specific training requests include finding and using reports, reading local data as available, assigning benchmarks, using tools to demonstrate lessons parts with help supports, and creating and setting up individualized pathways. The researcher also created pages of notes that provide a handout of directions for creating an individual pathway and lists of available lessons by grade level that can be used to choose from for the newly created pathways. The researcher created a timeline plan with times and activities. The researcher has also created editable data recording sheets that can be adjusted and used by students for self-monitoring and reporting progress that can be used in portfolios and agendas. The project deliverable with all of these items can be found in Appendix A.

The professional development plan will consist of the training materials needed for the PD. The training materials will include the official handouts provided by the Imagine Math contact and the other documents mentioned above that were created by the researcher based on the requests identified in the study. For planning professional development focused on improving student learning. Killion and Roy (2009) suggested the following 7-step Backmapping Model:

1. Gather data and analyze student needs
2. Identify the characteristics of community, district, school, staff, and department
3. Develop improvement goals and specific student outcomes
4. Identify educator learning needs
5. Study research for specific professional learning programs, strategies, & interventions
6. Plan intervention, implementation, & education
7. Implement, sustain and evaluate the professional development

Steps one and two of gathering data, analyzing data, and identifying characteristics were completed through the data collection and analysis. Therefore, PD planning will begin with step three by developing improvement goals and specific student outcomes. These goals and outcomes will come from the data analysis at this school. Since the data collected and analyzed came from interviews with the staff, they will be the target audience. The target audience for this PD will be the staff at Sage Elementary School who use the Imagine Math or want to use the Reflex program, which will be reinstated. The goals will include the following:

1. Provide beginning PD to all the teachers who use or want to use the programs and haven't been provided with any PD. Five of nine participants had no training. This will help cover the three focus group members and two interviewees who have not been provided with any PD.

2. Provide differentiated training to staff that have received prior PD, but would like additional PD on how to utilize different features of the program such as accessing & using reports, using helps & live teacher, setting up specific lessons, and creating new individualized pathways. These parts come directly from the specific PD requests and the lack of training comments.
3. Students will complete the beginning benchmark within the first six weeks of school and the middle benchmark by the end of the second week of the second semester. This provides report data for teachers to monitor growth and provide support for determining some of the curriculum for individualized pathways.
4. Provide follow-up professional PD check in later in the year to provide the continued beneficial support. This comes from the data showing not all the PD should be at the beginning of the year, and general comments for meeting individualized needs.

After clarifying the goals, the fourth step in the 7-step Backmapping Model is to identify educator learning needs. The educator learning needs were identified through the interviews and observations. The learning needs identified fell into a few categories. The largest category of need discovered was introductory professional development on using the different components of Imagine Math and Reflex for staff who have received no training. These PD needs include basic Imagine Math training, IM Blueprint training, and initial Reflex training. A secondary concern identified was the desire for follow-up IM training on creating and assigning new pathways for individualization, using journaling, utilizing report data, motivational features, and managing time for integration. Some staff needed the initial training on Reflex, and possibly a refresher training which will be brought back due to the requests and data showing staff preferred Reflex more than Imagine Math Facts. The district will drop the IM Facts and bring back Reflex. Finally, the remaining need was setting up cohorts for follow-up collaboration and support. The literature review addresses the fifth step of research.

The next step in the process is the plan and timetables which are shown with the following tables outlining the steps and resources to be used in the PD. Table 5 shows the first day of PD, which is used for introducing IM and IM Blueprint to staff who need or want all the basic information for staff new to the programs and features. IM and IM Blueprint are being combined by the company with one login where both programs are accessed. During PD groups will sit together depending on their focus of IM or IM Blueprint. Training manuals for these programs will be provided. These manuals provided from program support include the Blueprint Program Guide, and a short twenty-minute webinar about what's new for 2019 for Imagine Math and Blueprint including the meshing of the two programs, their reports, and the addition of second-grade materials into Blueprint.

Table 5

PD Timetable for Day 1

Time	PD Day 1: All teachers new to IM grades 2-6	PD Day 1: K-2 new to IM Blueprint	Resources
8:00	Snack & Welcome	Snack & Welcome	Power point
8:15	Quick intro to data supporting IM	Data supporting IM Blueprint	Data from white paper
8:30	Using benchmark settings	Using the diagnostic assessment	Look at sample class data
8:45	Teachers take sample benchmark test	Teachers take sample benchmark test	Teachers log in to see sample benchmark
9:00	Demo: individualization, adaptive features, online helps, math tools, journaling & teacher help	Demonstration: individualization, adaptive features	Whiteboard demonstration of key components of the lesson
10:15	Break	Break	
10:30	How to integrate IM into the math schedule	How to integrate IM into the math schedule	Discussion
11:00	How IM relates to school goals & expectations for IM	How IM relates to school goals & expectations for IM	Slide
12:00	Lunch	Lunch	
1:00	Getting started: grade level grouping & collaboration	Getting started: grade level grouping & collaboration	Grade level group discussion of support system & planning with teammates
1:30	Motivational aspects of IM: stars, avatars, points, class prizes,	Motivational aspects of IM Blueprint	Demonstration
2:00	Quantile ranges	Quantile ranges Actionable data	Power point
2:15	Break	Break	
2:30	Finding, setting up & reading reports	Finding, setting up & reading reports	Report samples, set up timeline to have benchmark done
3:00	Reflection	Reflection	Reflection/evaluation
3:30	End of day	End of day	

Table 6 shows the second day of PD is for the Reflex program. The basics are provided in the morning, and teachers who just need a refresher on the benchmark and reports can join the PD after lunch.

Table 6

PD Timetable for Day 2

Time	PD Day 1: All teachers grades 2-6	PD Day 1: Reflex review	Resources
8:00	Snack & Welcome		Power point
8:15	Quick intro to data supporting Reflex		
8:30	Individualization & adaptive features		
8:45	Teachers take sample lesson		Teachers bring own computers/ login
9:00	Three parts of the student experience (Crabby's Fact Fair, Coaching, & Fluency development games)		
10:15	Break		
10:30	How to integrate Reflex into the math schedule with expected time for fluency (green light)		
11:00	How Reflex relates to school goals & expectations		
12:00	Lunch	Lunch	
1:00	Getting started: grade level grouping & collaboration	Getting started: grade level grouping & collaboration	Power point

1:30	Motivational aspects of Reflex (avatar, coins, certificates, games, & other reinforcements- new games, tree house)	Motivational aspects	Demonstration
2:00	Monitoring progress reports	Monitoring reports	
2:15	Break	Break	
2:30	Finding, setting up & reading reports	Finding, setting up & reading reports	
3:00	Reflection	Reflection	

Table 7 shows a half-day PD set up about 8-10 weeks into the semester where reading reports, making adjustments, and other follow up questions can be addressed. PD is more effective when it provides continuous support throughout the year, where new issues, concerns, and question arise and can be addressed. The table shows the planning of additional PD through the semester for follow-up reasons.

Table 7

PD Timetable for Day 2 ½

Time	PD Follow-up1: IM/Blueprint	PD Follow-up 1: Reflex	Resources
8:00	Snack & Welcome	Snack & Welcome	
8:15	Quick questions related to IM components	Quick questions related to IM components	
8:30	Report types & what to look for	Report types & what to look for	Teacher computers
9:00	Use information from class reports	Use information from class reports	Teachers open own reports
9:45	Break into grade level groups to discuss results, planning, support, other	Break into grade level groups to discuss results, planning, support, other	
10:15	Break	Break	
10:30	Creating pathways	Teaming time for planning	Pathway handouts
11:00	Other resources available through IM		
11:45	Reflection/Evaluation	Reflection/Evaluation	Questions
12:00	Lunch	Lunch	

PD is at 8 weeks out to have the follow-up to help support ongoing needs. Support will be given for both programs where teachers can choose their individual needs, while having access to both.

Table 8 shows a half-day PD set up at three months into the school year where benchmarks will be set up with a plan for looking at data, growth, and plans can be made and adjusted depending on findings. Current reports can be printed, compared, and used for discussion. The benefits of different reports can be shown.

Table 8

PD Timetable for Day 3

Time	Follow-up2: IM/Blueprint	PD Day 1: K-2 Reflex	Resources
8:00	Snack & Welcome	Snack & Welcome	
8:15	Quick questions related to IM components	Quick questions related to Blueprint	
8:30	Discuss & share implementation strategies/successes; journaling	Discuss & share implementation strategies/successes;	
9:15	Use information from class reports	Use information from class reports	
9:45	Break into groups to discuss results, planning, support, other	Break into groups to discuss results, planning, support, other	
10:15	Break	Break	
10:30	Creating pathways for reteaching/enrichment	Creating pathways for reteaching/enrichment	
11:00	Setting up benchmarks		
12:00	Lunch	Lunch	

PD is at 13-16 weeks out to have the follow-up to help support ongoing needs and set up benchmark assessment. PD needs to be supported over an extended time for more effectiveness.

Rationale

The most common deficit found in the study was the need for PD. There were five teachers who stated they received no PD for the programs they were using. Of the four other participants, three of them wanted additional specific PD related to more advanced features and questions that have arisen after using the program for a couple of years. There was not any IM Facts PD since this component was added partway through the year for teachers to try at their own discretion. This means there should be a basic PD provided for using the online programs as well as the inclusion of more specific PD to meet the individual needs of teachers.

The proposed project is a three-day professional development plan based on the needs identified in data analysis. The professional development plan will include the training materials needed for the PD. The training materials will include the standard handouts provided by the Imagine Math contact as well as other materials written by the researcher based on the requests identified in the study. The PD should also be spread over time to provide the continued support that is both suggested and desired.

Review of the Literature

This literature review was conducted using the Walden online resources, including the Education Source and Thoreau databases. Since the genre chosen was PD based on identified needs, key themes included professional development, technology integration training, and TPACK. Most searches included a mixture of the following words: professional development, planning, quality, recommendations, training, evaluation, models, elementary, primary, educational, computers, technology, math, mathematics, TPACK, barriers, implementation, and individualization. The data collection also identified the additional key themes of differentiated, needs-based PD, continuous PD, facilitator expectations, and barriers. Many of the studies found in the research concurred with the data findings and stressed the importance of personalized professional development and continuous PD support. Chen and Herron (2014) recommended that trainers implement differentiated instruction to maximize benefits.

Genre

The genre chosen for this project was the professional development with training, curriculum, and materials. "Teacher professional development has been critical in preparing in-service teachers to meet the changing demands of their profession, as well as upgrade their knowledge and skills necessary to integrate technologies into teaching and learning"(Barbour et al., 2017, p.24). Since the data collected from the target audience identified different aspects of professional development as the greatest need and desire, PD should be the basis for the project study. PD also aligns with the TPACK framework, which integrates technology, pedagogy, and content knowledge. Chen and Herron (2014) noted that to improve teachers' TPACK, it is important to provide PD with differentiated instruction adjusting for individual's skills and experiences. The PD would support the framework by providing the technology related to the programs focusing on the content available and suggested pedagogies. Kelly and Cherkowski (2015) identified that there needed to be more opportunities for colleagues to reflect and share about teaching and learning. A full plan of PD should include the purpose, timelines, materials, and a detailed hour by hour plan.

Currently, the school district is continuing with the implementation of the Imagine Math and Imagine Math Blueprint programs for grades K-6 through the Clever platform. The district will discontinue the Imagine Math Facts portion and replace it with the return of Reflex for fact fluency support. Professional training for these programs was limited to a couple of days near the beginning of the year and had conflicts with many of PD opportunities. One example from the research data showed the K-1 teachers at Sage Elementary were unable to attend the IM Blueprint training due to a conflict with istation training, which is a state-required assessment program.

This literature review provided an overview of topics related to planning professional development. Professional development topic themes for this review have been broken into the major categories of relevant needs-based PD, PD with a tech-supported content-based focus, facilitator expectations, sustained support, and barriers. Longhurst, Coster, Wolf, Duffy, Lee, and Campbell, (2016) stressed that long-term PD promotes a learning environment that advances student gains. A consistent list of recommendations for teacher professional development includes active, hands-on instruction, alignment with specific content and pedagogy, collaboration, on-site support, remunerations, and sustained learning opportunities (Barbour et al., 2017).These recommendations overlap with the characteristics listed in Krimbel's research. A meta-analysis found high-quality professional development to be content-focused with pedagogical approaches, offer coherent instruction over time, and provide an active learning environment, opportunities for collaboration, and follow up coaching (Kimbrel, 2018). A current review is important for the inclusion of the best strategies for planning quality PD based on the needs discovered through the study.

Relevant, Needs-based PD

This section of the literature review examines how relevant, needs-based PD is an essential component of quality PD. Since the PD will be based on data and analysis gathered during the research study, it should relate directly to the identified areas of concern for this site. The needs-based PD can be broken into the sub-categories of relevant site-based PD, collaborative discourse among colleagues, and differentiated PD that meets the individual needs of staff. The PD for this project study should keep the feedback from the data analysis as a central focus of planning. Goodnough, Pelech, and Stordy (2014) confirmed effective PD is based on feedback from teachers gathered through interviews, focus groups, and surveys.

Relevant PD should be developed around the needs identified through data collection and analysis from the specific site. Joksimovic, Robertson, Dokic, and Drazeta (2019) identified supportive PD as having training topics developed from school needs and results with technical support for clear implementation. It is also important to consider PD is provided in an adult learning climate, so learning is improved when teachers feel supported, cared for, and respected as part of a professional community (Kelly & Cherkowski, 2015). Supporting a professional learning community (PLC) atmosphere is one way to support professional development for technology integration (Thoma, Hutchinson, Johnson, & Stromer, 2017). Some characteristics Thoma et al. listed for effective PLC's include a common mission, reflective practice, reflective discourse, and feedback while maintaining a focus on student learning. Having local, relevant PD helps keep the mission goals common to all and further supports pertinent discussions and interactions among coworkers. These common PD goals include basic training, differentiated pieces, utilizing benchmarks, and follow-up PD.

It is important to provide opportunities during PD for teachers to reflect, plan, and collaborate with their colleagues about teaching and learning in their local community. Combining data and good collaboration with a sense of collective responsibility for all students is beneficial as it supports the greater good for long-term, sustainable success (Hargreaves & Boyle, 2015). Peer collaboration was a common asset in almost every interview as a positive feature. One of the most effective ways to achieve meaningful PD for teachers is by incorporating collaborative learning (Song, Hur, & Kwon, 2018).Teachers work in teams, and it will be important to make sure to build in time for teams to talk and discuss ideas.

Encouraging discourse can help maintain a focus on the end product of student learning. Xic, Kim, Cheng, and Luthy (2017) suggested that a pre-training on the requirements of the digital content could benefit evaluation during PD. Xic et al. also mentioned it is vital to tap into teachers' interests and address practical issues to maximize PD benefits. One easy practicality is giving the staff access to the programs with a basic guideline paper ahead of time so they could explore areas of individual interest, note concerns, and bring questions and suggestions for discussion to the PD training if they choose.

PD should not be the same for all staff since they do not have the same needs. Using data from a needs assessment analysis allows PD leaders to align better and personalize PD (Karlin, Ottenbreit-Leftwich, Ozogul & Liao, 2018). In order to maximize the learning experiences for all staff, the trainer should use differentiated instruction (Chen & Herron, 2014). Grade-level differentiation has the greatest impact on technology application (Hatten & McDonald, 2016). Several participants in the study mentioned the need for PD that would support their individual needs and not be generic. Goodnough et al. (2014) noted that the relevance of PD was seen as key as one participant mentioned PD for teachers should be individualized just as teachers need to individualize instructions for students. Karlin et al. (2018) concluded that tech-PD experiences might not be planned for individualization due to expectations that are put on leaders or administrative requirements to provide district-specific PD. The PD will provide basic information for everyone with some differentiated parts that can help meet the needs identified through the study.

Research shows that novice and expert teachers have different desires and needs. Mahmoudi and Ozkan (2015) identified mentoring, observations, coaching, and evidence-based literature as PD formats sot out more by expert teachers while novice teachers participated in workshops and informal dialogue with colleagues. The PD should provide opportunities for teachers to discover new roles, develop new techniques, and refine their practice (Mahmoudi & Ozkan, 2015). There could be opportunities for the participants to share during the PD for any areas they have developed. The data from this study also demonstrated needs for different levels of PD from the basic introduction of the computer programs to more specific topics related to the specific programs. The PD for this project is considered phase 1 PD, where the PD focuses on a specific program at an individual site (Tekkumru-kisa & Stein, 2017). The specific programs will include IM & IM Blueprint and Reflex. It will be important to include basics, along with the specific requests identified. A successful PD can be adjusted and adapted to phase 2, where it can be implemented across multiple sites. To maximize learning for teachers, PD should provide differentiated instruction for all teachers (Chen & Herron, 2014). Zinger, Naranjo, Amador, Gilbertson, and Warschauer (2017) concurred listing increased individualization and more contextualized learning experiences as key factors of PD.

Tech-supported, Content-based PD

This section explores how more successful PD should be content-specific, technology-based, and pedagogy focused. The tech-supported, content-based PD can be broken into the sub-categories of PD that focuses on tech support, math specific content, and frameworks such as TPACK. PD can be used to provide the technical skills required to teach and use the programs well. Using PD to address the issues of teacher computer skills, provide time for teachers to learn to manage and become familiar with the resources, and technical support are the beginning steps for increasing technology use in the classroom (Delgado et al., 2015). Improving technical and management skills related to the programs can help teachers better use their time for planning. PD is the process used by school systems to expose teachers to new strategies, district initiatives, and new technologies (Alenzi, 2017). Xic et al. (2017) noted that technology integration requires more time for teachers to learn, plan, implement, and evaluate the tasks. The teachers will need to be given time to plan and discuss with their teams' ways to implement. There is a gap related to technology in what teachers are expected to know and do in a classroom (Matherson, Wilson, & Wright, 2014).Support for technology integration is more than troubleshooting technological problems; it includes support from leaders, colleagues, and school culture (Alenzi, 2017). Blackwell et al.'s (2014) study showed that support targeting teachers' understanding of technology for children' learning is important for helping teachers to integrate into the classroom.

Hsu (2016) suggested that PD activities about technology integration should focus on subject and practices for higher-level learning. Content-specific training for PD is more advantageous than a generic approach for any topic. Song et al. (2018) concluded that subject-specific content is more effective on teacher outcomes and student achievement. In a mix of studies, Killion (2015) found PD to provide significant association in the areas of math content, pedagogy, curriculum, integrating technology, and improving critical thinking. PD should relate to the topic of study, which will include Reflex and IM and be provided in an appropriate manner. Providing PD on programs being used for an entire class can help teachers better prepare for potential challenges and benefits and help teachers better utilize the tools (Barbour et al., 2017). Content-specific PD is one of the recommended strategies to help improve content skills and pedagogy (Song et al., 2017). Keeping the focus on PD for the computer programs will help with the identification of specific strategies, skills, and methods for these programs in the classroom.

Advances in technology allow for different forms of PD. Walsh (2017) identified TPACK and SAMR (Substitution, Augmentation, Modification, and Redefinition) as models to use to help use technology effectively and consider how the technology can support the content and not be used just as an add-on. Technology should be used to enhance methods and learning, not just fill time. The SAMR model is to encourage teachers to find new ways to use technology through modification of task redesign and redefinition with the creation of new tasks (Walsh, 2017). TPACK encourages teachers to be creative and be willing to grow in both technological knowledge and technological pedagogical knowledge (Seals et al., 2017). The IM program has a video components resource that will be available to enrich the PD.

Urbina and Polly (2017) concluded that teachers need to experience technology as learners where they can see the TPACK connection between technology, pedagogy, and standards. One participant had commented it was important to try the program as a student to truly understand what some of the expectations and experiences are. This experience provides better preparation for successful implementation. PD that utilizes TPACK methods can share the strengths of teachers at many different levels (Joksimovic, Robertson, Dokic, & Drazeta, 2019). Joksimovic et al. stated PD with TPACK would include showing the benefits of using technology, building self-efficacy with practice and demonstrations, integrating technology into lesson plans, and working together to integrate technology into the curriculum.

Embracing failure is a reality of exploring, creating, sharing, and trying new things from combing frameworks (Seals, Mehta, Wolf, & Marcotte, 2017). Teachers need to be reminded that everything is not always going to be successful and that they are likely to encounter problems. Neither model offers the best way to teach, but rather serve as reminders of being innovative and mindful of technology both in the planning and reflection of PD. Seals et al. (2017) suggested using communities of practice where the group is collaborative and have a shared goal Teachers comfort level and familiarity with technology was higher after participation in PD and moved teachers integration of technology from simple replacement to transformation (Killion, 2016). The PD should include a resource component where teachers can refer back to find explicit directions and notes to support their needs.

Continuous PD

This section examines how sustained support is a critical feature of effective PD. The components of continuous PD that are important include time, types of follow-up, reasons for follow-up, support, and purpose. Research has shown the mobile learning training needs of educators has been shifting from a focus on technology integration and pedagogical coaching to a focus on the need for sustained support and time (Crompton, Olszewski, & Bielefeldt, 2016). Sustained support over time often gets neglected due to costs and time. Karlin et al. (2018) noted the leaders in their study might not have had the time or resources to implement the follow-up that was needed.

A common theme found for effective PD is ongoing support provided to staff. PD should not consist of a single training without follow up and support systems. Follow-up is important to replace the ineffective generic PD to a more valuable PD that aligns to individual teacher’s needs with sustained support (Karlin et al., 2018). PD is vital to successful implementation (Karlin et al., 2018). Follow-up conferencing is vital to maximizing success with implementation (Hatten & McDonald, 2016). The ongoing support can be not only throughout one year but potentially even throughout multiple years. Studies showed that teachers who participated in multiple-years PD continued to have growth in achievement in the second year (Longhurst, Coster, Wolf, Duffy, Lee & Campbell, 2016). It is essential to incorporate time for reflection into the sustained PD opportunities (Matherson et al., 2014). There will be time for reflection at the end of each PD component.

Longterm support can be provided through a variety of ways such as follow-up PD, observations, coaching, mentoring, collaboration, discussions, videos, or time for a professional learning community. Teachers need to be provided with PD, long-term support, tools, and resources to integrate technology into the curriculum (Matherson, Wilson, & Wright, 2014). There will be PD follow-ups to assess new issues, support continued usage, and provide an understanding of report features. Research acknowledges the previous idea that PD is specific, sustained, and allows for interactive participation (Parsons, Hutchinson, Hall, Parsons, Ives, & Leggett, 2019). PD should help teachers integrate technology for the educational benefits and not just for the sake of including technology (Matherson et al., 2014). Hopefully, the PD will help with implementation planning for the teachers who have previously used the programs for the early finishers in math.

The analysis showed that teachers did not like PD for creating or using examples that could not be applied in the classroom (Zinger, et al., 2017). Teachers in another study viewed the purpose of PD is for new concepts and collaboration, not for fun ideas like collecting badges, playing games or participating in scavenger hunts (Parsons, Hutchinson, Hall, Parsons, Ives, & Leggett, 2019). PD planning and implementation need to be coherent and meaningful to participants.

Good planning should minimize constraints and provide an appropriate environment for the PD (Goodnough, Pelech, & Stordy, 2014). Many studies pointed out support and collaboration as factors of effective PD. Liu, Tsai, and Huang (2015) noted that teacher training is more than just collaboration and should include both sharing and support among colleagues. This sharing includes providing constructive feedback by peers and not just mentors. With collaboration and sharing being effective strategies, it is worth noting there is a difference between the questioning of ideas of novice versus experienced teachers during observations and discussions (Liu et al., 2015).Teachers with less experience using technology might increase their motivation from working with someone who has more practical experience (Jorksimovic et al., 2019).

Providing time for teachers to have professional discussions and sharing can be a beneficial way to use some of the time used in follow up PD. Ciampa (2017) recommended that districts support PD by encouraging participation in local communities of educational professionals. Systemic staff development, opportunities to collaborate, and coach one another are the steps needed to provide time for teachers to develop technology-based learning (Yu, 2013). Experienced teachers seek out PD focused on mentoring, coaching, and research-based literature (Mahmoudi & Ozkan, 2015). Xic, Kim, Cheng, and Luthy (2017) suggested that it is important for teachers to spend time on evaluating digital content, and this process will help improve teachers' TPACK.

Facilitator Expectations

The multilevel PD should be considered during planning by the facilitator. The facilitator plays a big role in making sure all components of PD are included. It is commonly accepted that a well-prepared facilitator is essential for ensuring effective PD (Tekkumru-kisa & Stein, 2017). The role of PD facilitator is important to all staff and team members. The facilitator should make sure to connect the professional development directly to the classroom and provide opportunities for teachers to share and collaborate as these were a couple of the most frequently identified characteristics appreciated by teachers (Goodnough et al., 2014).

Facilitators are to provide support to the participants in whatever design of PD is utilized. The facilitator should provide logical support, scaffold the design process, and monitor the design process (Becuwe, Tondeur, Roblin, Thys, & Castelein, 2016). Tekkumru-kisa and Stein (2017) also mention the importance of a facilitator to help foster a professional learning community, develop math skills, and adapt to the local needs and interests. Tekkumru-kisa and Stein concluded there should be an expansion of PD that uses video as a central teaching tool in order to expand its scalability. The facilitator should make sure to incorporate ideas that are important to the participants. Active learning is where colleagues provide feedback to instructors and have opportunities to observe each other have a positive impact on job satisfaction (Song et al., 2018).

Barriers

There are challenges and barriers that can affect the planning of PD. The barriers identified in Kimbrel's (2018) study included financial constraints, time constraints, and teacher attitude. Support for PD can be paid working time and providing substitutes, but these choices are often constrained by budgets. These budget constraints, costs paid by teachers, salary incentives, the availability of time, commitment and resources, availability, and pressure are a few of the other challenges listed (Badri, Alnuaimi, Mohaidat, Yang, & Al Rashedi, 2016). Badri et al. found that conflict with work schedule and prior responsibilities as some of the most common barriers found in their study.

McChesney and Aldridge (2019) broke barriers for high-quality evaluation of PD into practical barriers and psychological barriers. Their list of practical barriers included time, effort, and cost required to implement best practices, the complexity of school environments, lack of easily available evaluation tools, and capacity issues. Their psychological barriers included the avoidance of positions of vulnerability for teachers and leaders, and potential impact of evaluations on funding, ratings, or other factors.

Finally, effective PD should include monitoring and evaluation. Goodnough et al. (2014) stated the importance of providing time for everyone to reflect on their experiences and offer input. Polly (2015) suggested further studies on PD benefit evaluations should compare teachers' participation in PD by looking at student-level data. Karlin et al. (2018) concluded that their study showed most PD evaluation did not extend past self-reported teacher data and suggested that using other data such as observations and student achievement scores might be beneficial for both planning and implementation of tech-PD. Goodnough et al. (2014) concluded that it was important to consult with participants throughout the PD to be sure to address their ongoing needs and concerns.

Project Description

The project description will begin with a description of the implementation timetable. Next will be a presentation of the needed resources, existing supports, and potentials barriers with potential solutions. Finally, the project description will conclude with the roles and responsibilities of those involved.

Implementation Timetable

The proposed PD would begin near the beginning of the school and continue through the first semester. The proposed project is a three-day professional development plan based on the needs identified in data analysis. The first two days of PD would be either before school starts to the first couple weeks of school so that training can begin early in the year. The next PD would be about eight weeks later with follow-up addressing the ongoing needs of staff. The final PD would be about three months after the initial PD. This would continue to address the ongoing needs as well as support collaborative groups with similar needs, so staff can use each other as peer resources and support. District coaches would also be invited to participate and help with follow up support through the year.

Needed Resources and Existing Support

There are several resources needed for this PD project to be successful. First, there are support fliers, video resources and handouts needed from the Imagine Math and Reflex companies or contacts about how to use the programs, access to the programs for all participants, staff computers with clever logins, materials provided by the researcher based on requests, and support from the school/district. The school support consists of release time or use of in-service time, space for presentation, technological support with computers brought by staff, a projector, and use of the photocopy machine. The researcher will provide a timeline, copies of materials, slide presentations, and reflection materials.

There are existing supports of staff members who have used the programs in the past. They can provide valuable assistance and collaboration. The researcher has had significant training in both programs and is willing to provide training. The district also has flexible coaches available to help all staff and sites with technology, training, and support throughout the school year. They can provide assistance before, during, and after training times. They also are available to lead, assist, or observe any lesson. Each set of the grade level bands K-2, 3-4, and 5-6 have common planning times as well as school-wide time during Wednesday afternoon.

Potential Barriers and Solutions

There are a few prospective barriers to account for with this professional development, but not any that should compromise the overall PD plan. Potential barriers for this professional development project include fitting the PD into an acceptable scheduled time slot, finding release time for teachers to attend training and technological resources. There are a few ideas to address the release time and technological resources. The more prominent barrier will be scheduling the PD to a convenient, acceptable time that works for the staff and school.

First, the district provides one week of optional paid PD before the school year begins so that teachers have the choice to become better trained in many different areas. This would be the easiest solution for the two days of training at the beginning of the school year. The problem with this possibility is that it is optional and may not be chosen by all the potential participants. A second choice would be for the principal to use some of the site PD time that has been prescheduled for the beginning of the year. Another option would be to provide half-day substitute teachers on Wednesdays since the students are only at school for the morning. This would minimize additional costs to the school and district since the cost would be for half-day substitutes. This could present the problem of finding enough substitutes to cover all the participants on a given day.

The PD could also be broken into half-day segments and implemented during Wednesday afternoons when teachers are not responsible for students. This would be the most cost-effective method, though it might be unpopular with participants to lose a half-day of planning and prep time. If this method is used, it is likely the PD will not fall on two consecutive weeks because of the lost planning time. Another half-day method is to use substitutes to cover one teacher in the morning and a different teacher in the afternoon on any given day. This has a financial cost to the school, but has been used for science training and broken by grade level bands such as grades K-2 and 3-6. The burden would fall to the facilitator having to present in the morning and repeat the presentation in the afternoon. Finally, the half-day follow-up sessions could be accounted for in prescheduled in-service days, half-day Wednesday afternoons, or during two of the grade level meeting times set up at the beginning of the year.

The technological resources should not be a major barrier since the school has projectors available in the computer lab, the library, and several classrooms. Teachers should have their own laptops available for training, but there are chrome books or desktops available in the school computer lab. The district will also need to make sure teachers have access to programs through Clever, but this should not be a problem since there is continued access for current teachers and changes and new accounts are supposed to be set up the first week of July, well before the school year begins.

Roles and Responsibilities

The roles include facilitator, principal, teacher participants, and district coaches. The researcher will take on the responsibilities of the facilitator. The major responsibilities fall on the facilitator. The facilitator will have to plan with the principal to set up a schedule that is suitable to both the time and budgetary constraints. The facilitator will contact the district curriculum coordinator and program contacts for any necessary information. The researcher will provide a timeline, copies of materials, slide presentations, and reflection materials as the facilitator. The participants will need to bring laptops and login information. The facilitator will also contact the district coaches to attend and/or help with the PD. The responsibility of the participants is to attend, participate, and begin using the programs.

Project Evaluation Plan

The chosen project was a Professional Development Plan. The evaluation planned for this PD project will be a combination of a summary provided through reflections by participants and data collected about the usage of the programs. The reflection questions should identify if staff feel the PD sessions are meeting their individual needs and supporting their implementation of the programs. Data can be collected about the usage of IM and Reflex and numbers to show how many students have taken the beginning and middle benchmarks as set by the goals. Average usage times can be found for each grade level. This should clarify how much the programs are being used at different levels and if all students are using the programs.

This combination evaluation is logical because it will provide information about how well the PD has met the needs of the staff. This evaluation should identify if each staff member has received their basic training, the differentiated needs requested, and support to implement the programs successfully. The data gathered should provide basic information about how much time students are using the programs, whether they are completing assignments and what type of improvement is shown.

The project goals will include four parts. The project should provide beginning PD to all the teachers who use or want to use the programs and haven't been provided with any PD. Another goal is to provide differentiated training to staff that has received prior PD but would like additional PD on how to utilize different features of the program such as accessing & utilizing reports, setting up specific lessons, and creating new individualized pathways. A third goal is students will complete the beginning benchmark within the first six weeks of school and the middle benchmark by the second week of second semester. This provides information in the reports to teachers to show growth and can help them identify and create a pathway that might be more suitable to the individual student's need. This should help staff who wants training on reading the reports, using them to monitor progress, and adjust/create pathways for struggling students. Finally, the last goal is to offer follow-up professional PD check in later in the year to provide the continued beneficial support.

The evaluation goals should identify whether the PD was well-designed for the needs of the staff. The first goal should be to identify the number of participants who attend each of the training days. A second goal will be to determine if each of the PD training meet the needs of individual participants. A third goal will be to identify if teachers are meeting the project goals and implementing the program on a more regular basis. This information should be gathered through two different means. First, the administrator's school report will show how many students have taken benchmarks, student growth, usage time, lessons passed, and other basic information by grade-levels and school-wide. This can be compared with the previous data for the school shown in the school report for the previous year. Some of this data is presented in Appendix A. The second part of data should be gathered by a short survey of questions asking staff about any changes in their usage.

The information will be helpful to the staff and principal to show areas of strengths, concerns, and continued needs. This information is also important to the school data team and the district data team. The district uses school reports and data from each of the schools for a variety of purposes. This includes providing paid locally presented PD sessions in the summer based on staff needs/requests, back to school PD and also to verify if programs are being used as they rank online programs for purchase and removal. The summary of reflections should provide information about the PD and whether it would be beneficial to implement district-wide. This PD could easily be added to the summer sessions. The benchmark data information will identify usage, grade-level scores, and growth for the data team who want to have short term assessments to review and better adjust to students' needs.

Project Implications

The study was done for the purpose of understanding how teachers are using the new math software programs and to analyze their perspectives on differences they notice in students' math learning and comfort with online math tools. The research has helped illuminate areas of need at the local school. The greatest area of need was for professional development to support implementation and understanding of the programs. Providing the needed PD at this school could change the usage of technology as an add-on for early finishers in some classrooms to a more integrated approach of using technology to support the content for all students. The integration of the programs and use of individualized pathways could improve student's ability to use online math tools, provide remediation and enrichment, and support the current curriculum. There could also be a support system set up in the school for teachers to assist each other with technological concerns as well as share successful ways to integrate the programs.

The data collected can also continue to inform the district of teachers' continuous needs. The district has heard the concerns and request for the return of the Reflex program and will be bringing the program back for the 2019-2020 school years. Having a successful PD at the local level could potentially provide for future district level PD and to other locations using the IM and Reflex programs. The PD could also be utilized and encouraged by the district elementary support coaches.

Section 4: Reflections and Conclusions

Introduction

The project in section three is a result based on the findings from the study of looking at the integration of technological math programs into the classroom. The outcomes from this study showed the project should target the concerns of the participants such as lack of training and more specific training on both Imagine Math and Reflex Math. The targeted PD included a range from basic training information to specific needs with follow-up meetings to ensure training needs have been met. The basic training will include an introduction to data supporting the use of Imagine Math (and the Blue Print portion which has been integrated into IM), the individualized features from the program, the basic tools available in the program, ways to integrate, motivational aspects, and reporting features. Other more specific training parts will include using creating new pathways, assigning individualized pathways particularly for students who are struggling or need more challenge, journaling with the program's help formats, more specifics on reports types and what to look for, ways to integrate the data into classroom data binders, individual data binders, and samples of data pages that can be adapted. The Reflex training will include the basics of how to set up your classroom, link teachers, individualized features, basic parts of student experience, motivational features, and how to integrate into the classroom. The more specific training will include using the different reports, adjusting data recording reports for class data and individual data binders, and linking classrooms to multiple teachers for sharing data.

This section will include reflections over the PD project. The purpose of the PD was to provide initial training on the programs, additional training on specific features of the programs, and follow up support training to the staff at Sage Elementary. The program for this project study is a three-day PD broken into parts throughout the year to meet the beginning and ongoing learning needs of the faculty and staff. The PD plan will include basic training for Imagine Math, IM Blueprint, how these two programs have been integrated and training on Reflex Math.

The beginning PD will be broken into basic features, data, benchmark tests, individualized features, integration into the schedule, expectations, collaboration, motivational features, and reports. The follow-up PD's will provide time for teachers to bring up current issues, report types, current data discussions, team planning, creating pathways, and follow-up benchmarks. There is potential that the PD can be adjusted and used at the district level since the district curriculum team has recently decided to adopt IM and Reflex for all the elementary schools. The PD slides and information can be found in Appendix A.

Project Strengths and Limitations

There are several strengths for this project study. First, the initial data collection used both interviews and observations to collect and triangulate data. The outcomes of this study were used to determine the target goals of the PD plan. Providing training and support can boost success (Killion, 2016). Using the data to provide targeted PD based on the needs identified from the data findings is specific to the site. The suggestions from the participants helped shape the PD and ensure that both the basics of how to use the programs as well as more developed strategies on setting up individual paths and using reports are included. Hsu (2016) listed the lack of PD as a major barrier to technology integration.

Another strength of this project is that the researcher who planned the PD project is very familiar with the programs, works with the staff using the programs, has used the programs in the past, has received formal trainings with IM and Reflex and has had contact with program coordinators. The targeted approach to planning and providing PD should facilitate teachers' abilities to utilize their training in classroom implementation. The use of modeling the parts of a lesson and giving teachers time to explore is beneficial. Hsu (2016) identified modeling as an important piece of PD. The evaluation piece of the PD will provide feedback information about the effectiveness of the PD and identify the number of benchmark assessments given. This information would be beneficial for the administrative stakeholders in providing information both about the PD and the programs. Blackwell, Lauricella, and Wartella (2014) identified the importance of identifying how much teachers are using available technology.

This project study also has some limitations that include size, time, and budget. The initial data collected was from only nine participants because it is a small school with a limited amount of staff. The project PD is based on the summary of needs from the small set of participants and is also developed for only a small group of no more than a dozen. A small group limits the number of participants in each grade level band, which could limit the support and discussion opportunities. Even with a successful PD implementation, there could be unexpected limitations on the ability to transfer the PD plan to a larger group since it was developed for the small site.

Financial and time constraints are other limitations in this project study. There is limited control for scheduling the PD, as it needs to be cleared by the administration that are in charge of PD and teacher schedules. McChesney and Aldridge (2019) found time and money as a couple of hurdles to PD. There is no guarantee that all the staff who wish to participate will be able to attend due to scheduling restraints. Badri, Alnuaimi, Mohaidat, Yang, and Al Rashedi (2016) found that conflict with work schedule and prior responsibilities as barriers to PD. It will be up to the administration whether they will provide time, financial support, substitutes, or other compensation for the PD.

Recommendations for Alternative Approaches

With the major problem being lack of PD in general and more specific training, any clear project should be to provide professional training as was planned in this project. Alternative approaches should still be focused on the necessity for training and support for the programs IM, IM Blueprint, and Reflex. Alternative approaches for training could include a completely online support system, a hard copy support manual for self-training or the assistance of the district coach.

One alternative approach would be to provide an on-demand online PD training program. This would require setting up an online site with a table of contents to each of the parts for training. These would include several tabs for each of the PD components, including data, benchmarks, individualized features, motivational aspects, finding and using reports, and creating pathways. Each tab would contain links to video clips related to the component. The tab would also need fliers that are written to provide procedural notes for the components. The site would be available to any participant at their own convenience from any computer and location. Portions could be done in short segments. The problem with this method would be the lack of collaboration, cooperation, discussion, and face to face interactions.

Another alternative would be to provide a reference manual with all of the training components. There would need to be clear organization, labels, and dividers for each of the components. This method would not be the best choice. It would require lots of research and writing for each of the components. The writing instructions would need to be copied and collated into the binders. This method is neither efficient nor interactive.

Finally, the district coach could serve as a support resource. The coach would serve as intermediary support and would need to be well-trained or keep communication with program representatives. The coach could meet on an as needs basis. The coach could set up appointments or sessions with individuals or groups to provide answers to applicable questions.

Scholarship, Project Development and Evaluation, and Leadership and Change

Scholarship is an academic study at a high level. This Ed. D. program provided an opportunity for me to develop my skills as a scholar. The classes were demanding, but relevant to providing me the skills for all the parts of this project study. I have developed my skills for writing and research immensely. My extensive reading and writing for the literature reviews have provided me with many academic conversations with my colleagues and peers that I would not have had otherwise. I often read current research and articles in journals, but not compared to the amount I needed to research and read to be able to write an effective literature review.

This development of this project required the use of scholarly processes. The researcher needed to use scholarly methods throughout the entire project. These methods included an ethical, bias-free analysis of the data collected using member checks and triangulation. A scholar collects, organizes, and analyzes the data to provide findings in an accurate, objective manner identifying relationships and themes related to the research questions. The scholar needs to use these findings to suggest projects and plans to provide positive social change that can affect the community. This is true whether the community is a small faction or an all-encompassing group.

Project Development and Evaluation

A scholar develops the project based on the needs and problem identified in the analysis. First, a scholar should identify a potential genre of a project that can best help solve the problem identified. The method for this project was to create a plan to provide professional development training. Scholarly project development includes many features. The scholar needs to identify the purpose, goals, and audience. The scholar would also need to provide a timeline, activities, notes, materials, implementation plan, and evaluation plan. Then the scholar can conduct research related to the specific genre of project chosen. I found many more parts to developing a project than I initially expected.

The scholar needed to use research for many parts of the literature review. The literature review is still one of the most difficult parts of the project for me. One part was to identify why the PD genre is appropriate for addressing the problem. Another part was to search through many terms related to PD to write a critical review of any topics related to the PD project plan. Many current research papers were used to demonstrate saturation of peer-reviewed research. When initially searching for research, it seems easy to find some general terms such as PD, technology, elementary, barriers, and TPACK, but other terms were needed to find more relevant research. Finding appropriate research often provided some additional vocabulary for further research and investigation. Terms such as effective, successful, continuous, and ongoing were identified from reading as words to look for and use in future searches. Sometimes research would reference another article that should be found and read. Reading research often provides access to other scholarly language and authors that I may not have been otherwise identified.

The scholar used the information gathered from research to identify the best methods for implementation of the project. The literature review identified both successes and barriers that could be planned for ahead of time. There were many parts I expected but found many new considerations that I had not initially planned. The information gathered helped generate and refine plans for the project. Finally, the project would need to be evaluated to see how well the goals were met. A scholar should always evaluate and share results with stakeholders. Evaluation is a scholarly method to provide feedback and suggestions for future projects and research. I have been surprised at how many people have asked about my findings and when I could share more.

Leadership and Change

A scholar should be a vessel of leadership and change. Leadership is needed to bring forth change. The goal of a scholar is to research and create plans that have positive social change. I wanted to make a plan that would be both realistic and meet the needs that were identified in the data analysis. With this plan, I had to learn to look at details and adjust them as I read more research. After reading extensive research, I had to make conscious decisions on what best practices to use and which were impractical. I like to help bring new ideas and practices that are beneficial to my school. My district began a large change of providing a week of optional paid PD led by experts from within the district, and this provides a great opportunity for my project to be implemented and expanded over time.

Reflection on Importance of the Work

The work for developing this project is important. Social change can only occur when there is someone willing to research and plan for changes. In one of my trainings I remember being told that finding problems and identifying issues is easy to do, but only be done when offering solutions. I was told I should always have two potential solutions for any problems I choose to acknowledge. Otherwise, it is just a complaint. Though I feel this information is great to remember, I would have many different thoughts about these recommendations.

First, it is easy to complain about a problem without having really identified the root of the problem. As a scholar, I would need to better understand an issue through data collection and analysis. Only with a true understanding of the problem would I be able to offer useful suggestions for resolving the issue. This work helped clarify the problem with data. With a detailed description of the problem, I could then think about possible solutions. The work also provided a methodical way to work through the problem to find out what the best and most realistic choices might be. From here, I could devise a plan that I thought was feasible and would help. Research provided ways to optimize the parts of the plan.

This process required perseverance with sacrifices of time and the patience of rewriting endlessly. Writing is not my strength, and there were many times where I wish I had reverted back to a quantitative study. At times, I wished I had decided to get a doctorate in math where the work would be more numerical and succinct. I know I questioned why I was continuing the process with all its demands. I am happy and relieved to have persisted through for completion of the project and the end-product of the doctoral degree.

Implications, Applications, and Directions for Future Research

The purpose of this study was to understand how teachers used the online math programs and their perspectives and experiences on differences they notice in students' learning. The potential for social change was to contribute to the preparation of teachers for the online programs by providing PD developed on the discovered needs. The PD could help fill the gaps of how the math technology programs were being used compared to how they could be used to better utilize the IM, IM Blueprint, and Reflex programs.

The findings from this study showed that a targeted PD was needed to provide both basic training needs as well as more advanced training with specific features and reports. The PD needs to provide basic training on using the programs, show benefits of the programs, demonstrate lesson features, show ways to find and use reports, explore motivational features, discuss ways to integrate into math, show how to monitor student progress, set up benchmarks, and create individualized paths. This PD has the potential to provide staff with the support they need to utilize and integrate the programs more successfully and not just provide use the programs for early finishers or let students work on the default settings provided by the program. This PD plan would not necessarily be applicable to the larger educational setting, as it was created for the site. Other schools using the same programs could find it beneficial. The PD and evaluation results could potentially provide useful information to the administrative stakeholders for the school and the district as these programs are being expanded district-wide.

Another finding from the data collected showed there was an overall opinion of participants who wanted the return of Reflex to replace the IM Facts portion of IM. After interviews and expressing their perspectives with the researcher, the participants and other staff members shared this request with the curriculum coordinator who decided to bring the Reflex program back in the fall. A recommendation for the district is to see if this program could be adjusted and expanded to a district-level PD. A survey could provide enough information to gather needs related to these programs. I would recommend the district use their data team to monitor progress and usage of the programs and evaluations from the PD to help make future decisions. This study and project have revealed that there is work that needs to be done based around PD needs, gaps, and planning. I would recommend future research focus on the evaluation portion of PD and how these evaluations could help improve future PD processes and choices for districts.

Conclusion

For this study, the problem I began with was to gather information about how teachers were using the IM and Reflex programs and their perceptions on differences they noticed in students' learning. In order to gather the information, I interviewed the participants at the site and observed their classrooms to identify the nature of how the math technology programs were being utilized. The data from this study showed the staff was trying to use the programs to the best of their abilities, which varied immensely. This included a range from no training at all to staff with moderate training. Some teachers integrated the programs into a regular routine while others allowed early finishers to sign into the programs. Some staff resorted to letting the students play with the programs without the training to support the students. There was no other district data found related to using technology programs in the math setting. Many of the current supports were trying to find a peer who has more experience with the programs, and peer interactions served more as a troubleshooting process.

These findings revealed there was a shortage of professional development to meet the training needs of the participants. The PD needs identified many parts including basic training on both programs, support with finding time to integrate into the classroom, details on programs features, sample lessons, collaboration time, monitoring data, and advanced support of setting up individual pathways. Presentation of these features would better prepare the staff to effectively implement the programs and use them to support the current curriculum. The IM and Reflex programs are under budgetary monitoring to see if the staff is using them enough to defend the costs of continuing the programs. Minimal data has been collected to gather teachers input. This project helped identify that the teachers like the programs and want to use them, but do not have the training needed to use them as well as they would like as shown in Table 3.

Given these results, I thought the best solution would be to create a PD plan based on the identified needs. The PD program could fill the training gaps that were identified. When implemented, the PD plan would provide further information on how well it met staff needs through evaluation. The evaluation can help improve the PD plan and implementation for future use. This PD plan could them be expanded to include the district and could serve as a beginning step for other schools. I recommend implementing the PD plan and using the information gathered in the evaluation to continue to improve future PD.

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Appendix A: The Project

The component chosen for the project is a Professional Development Plan. The proposed project is a three-day Professional Development Plan based on the requests for PD on the programs to include the topics of basic training, creating and using new pathways, finding and using reports, using the report data, using journals, and math helps. The Professional Development Plan will consist of the training materials needed for the PD. The plan includes four timetables, two power point presentations, and handouts created by the researcher. These handouts are based on the requests identified in the study. Any materials provided by the companies will not be included since they would not be original materials.

The timetables have a first column with an outline of times and activities. These times and activities can be adjusted at the time to meet the needs of the individual participants in particular. This would allow some topics to be shortened or extended if the group needs an adjusted time for specific training. The second column shows other related activities that allow for differentiation factors. The third column lists the materials needed for the training.

Table 5

PD Timetable for Day 1

Time	PD Day 1: All teachers new to IM grades 2-6	PD Day 1: K-2 new to IM Blueprint	Resources
8:00	Snack & Welcome	Snack & Welcome	Power point
8:15	Quick intro to data supporting IM	Data supporting IM Blueprint	Data from school
8:30	Using benchmark settings	Using the diagnostic assessment	Look at sample class data
8:45	Teachers take sample benchmark test	Teachers take sample benchmark test	Teachers log in to see sample benchmark
9:00	Demo: individualization, adaptive features, online helps, math tools, journaling & teacher help	Demonstration: individualization, adaptive features	Whiteboard demonstration of key components of the lesson
10:15	Break	Break	
10:30	How to integrate IM into the math schedule	How to integrate IM into the math schedule	Discussion
11:00	How IM relates to school goals & expectations for IM	How IM relates to school goals & expectations for IM	Slide
12:00	Lunch	Lunch	
1:00	Getting started: grade level grouping & collaboration	Getting started: grade level grouping & collaboration	Grade level group discussion of support system & planning with teammates
1:30	Motivational aspects of IM: stars, avatars, points, class prizes,	Motivational aspects of IM Blueprint	Demonstration& teacher practice
2:00	Quantile ranges	Quantile ranges Actionable data	Power point
2:15	Break	Break	
2:30	Finding, setting up & reading reports	Finding, setting up & reading reports	Set up timeline to have benchmark done
3:00	Reflection	Reflection	Reflection/evaluation
3:30	End of day	End of day	

Table 6

PD Timetable for Day 2

Time	PD Day 1: All teachers grades 2-6	PD Day 1: Reflex review	Resources
8:00	Snack & Welcome		Power point
8:15	Quick intro to data supporting Reflex		
8:30	Individualization & adaptive features		
8:45	Teachers take sample lesson		Teachers bring own computers/ login
9:00	Three parts of the student experience (Crabby's Fact Fair, Coaching, & Fluency development games)		
10:15	Break		
10:30	How to integrate Reflex into the math schedule with expected time for fluency (green light)		
11:00	How Reflex relates to school goals & expectations		
12:00	Lunch	Lunch	
1:00	Getting started: grade level grouping & collaboration	Getting started: grade level grouping & collaboration	Power point
1:30	Motivational aspects of Reflex (avatar, coins, certificates, games, & other reinforcements-new games, tree house)	Motivational aspects	Demonstration& teacher opportunity
2:00	Monitoring progress reports	Monitoring reports	
2:15	Break	Break	
2:30	Finding, setting up & reading reports	Finding, setting up & reading reports	
3:00	Reflection	Reflection	

Table 7

PD Timetable for Day 2 ½

Time	**PD Follow-up1: IM/Blueprint**	**PD Follow-up 1: Reflex**	**Resources**
8:00	Snack & Welcome	Snack & Welcome	
8:15	Quick questions related to IM components	Quick questions related to IM components	
8:30	Report types & what to look for	Report types & what to look for	Teacher computers
9:00	Use information from class reports	Use information from class reports	Teachers open own reports
9:45	Break into grade level groups to discuss results, planning, support, other	Break into grade level groups to discuss results, planning, support, other	
10:15	Break	Break	
10:30	Creating pathways	Teaming time for planning	Pathway handouts
11:00	Other resources available through IM		
11:45	Reflection/Evaluation	Reflection/Evaluation	Questions
12:00	Lunch	Lunch	

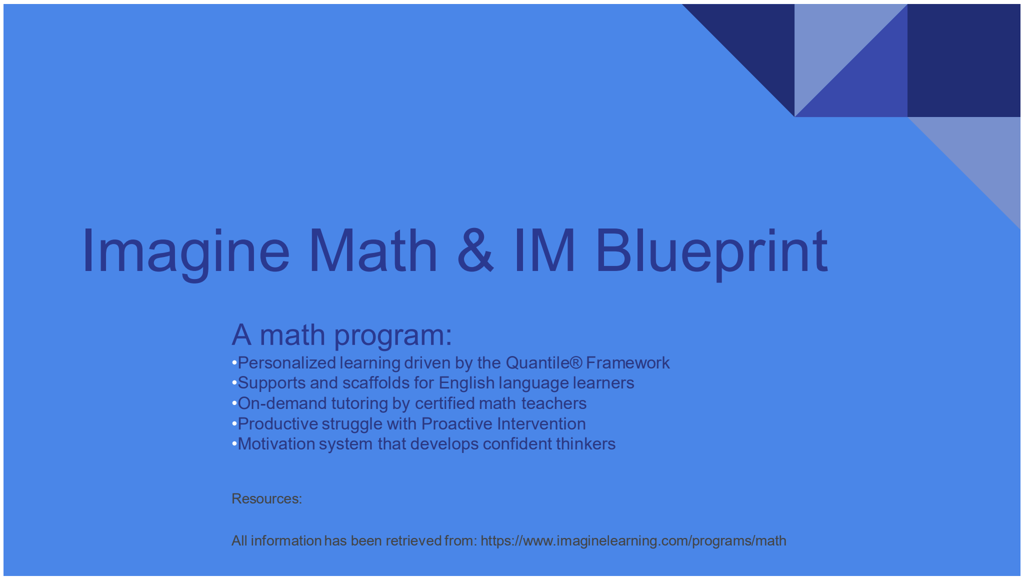
PD is at 8 weeks out to have the follow-up to help support ongoing needs. Support will be given for both programs where teachers can choose their individual needs, while having access to both.

Table 8
PD Timetable for Day 3

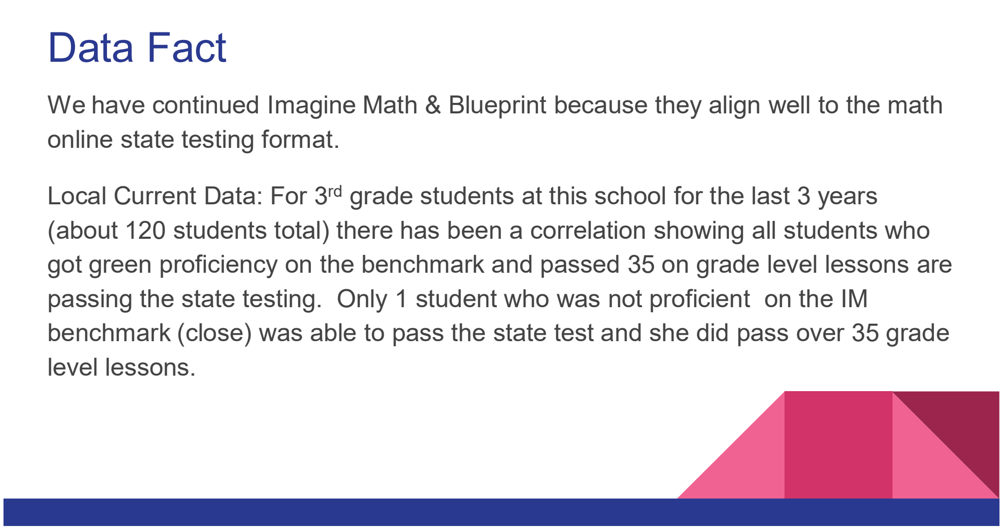
Time	Follow-up2: IM/Blueprint	PD Day 1: K-2 Reflex	Resources
8:00	Snack & Welcome	Snack & Welcome	
8:15	Quick questions related to IM components	Quick questions related to Blueprint	Teacher laptops
8:30	Discuss & share implementation strategies/successes; journaling	Discuss & share implementation strategies/successes;	
9:15	Use information from class reports	Use information from class reports	Teachers bring computers to login & see own reports
9:45	Break into groups to discuss results, planning, support, other	Break into groups to discuss results, planning, support, other	(If possible have admin print out reports ahead of time to share)
10:15	Break	Break	
10:30	Creating pathways for reteaching/enrichment	Creating pathways for reteaching/enrichment	Pathway handouts
11:00	Setting up benchmarks		
12:00	Lunch	Lunch	

PD is at 13-16 weeks out to have the follow-up to help support ongoing needs and set up benchmark assessment.

The power point presentation for IM & IM Blueprint is shown below. A photocopy will be provided to participants for reference and notetaking.



Notes: Slide show presentation for IM & IM Blueprint for day one. Slides can be accessed if needed during the follow-up PD. The last page shows individual video trainings available for teachers who have the option of individualization/differentiation that can be utilized during any repetitious segments.



Notes: Presentation of data that relates to this school. Begin with introduction of how sample of data correlates to the state PARCC test proficiency level. Allow & answer questions.

2018-2019 School Data from April

Beginning April Data		Goals & Expectations	
Ave. Quantile Growth	77.54	Ave. Quantile Growth	37-50
Ave. Weekly Time	18 min	Ave. Weekly Time	60 min
Ave. Weekly Lessons	1.84	Ave. Weekly Lessons	2
Ave. Lessons Attempted	37.12	Ave. Lessons Attempted	30+
Ave. Lessons Passed	26.99	Ave. Lessons Passed	30
Ave. Grade Level Pass Rate	90.8%	Ave. Grade Level Pass Rate	80%
Students with Benchmarks	148	Students with Benchmarks	200
Ave Time	12 hrs 12 min		

200 students enrolled, 89% took first benchmark, 66% with second benchmark; some registered students did not use the program due to abilities

Notes: Present the data for this school from previous year to show the expectations and compare with actual data to promote discussion of strengths & areas of improvement. Ask for celebrations of what is being done well. Ask for areas of focus.

2018-2019 School 2nd Benchmark Growth

Category	Beginning of Year	2nd Benchmark
Far Below Basic	20 %	11.5 %
Below Basic	21 %	24.3 %
Basic	25.5 %	25.7 %
Proficient	32.5 %	47.2 %
Advanced	1.0 %	1.4 %

Data is based on 148 students who have completed the benchmarks

Many 2nd grade students have been able to take the second benchmark, because they did not get access to the program until near the middle of the year.

Notes: Expected growth is 75 for the year, so there should be 37.5-50 points growth for the 2nd benchmark which was taken anywhere from December to February of this year. Reminder that this is school level data and we will look at grade level and classroom data later in the year. Ask for celebrations and areas of focus for future.

"Think 30" Goal is for students to have 30 lessons passed by the end of the school year

Local data for our school

Average Lessons Attempted	37.12
Average Lessons Passed	26.99
Average Math Helps per student	13.5
Average Live Helps per student	1.1

There should not be a large difference between lessons attempted and lessons passed for individual students or they are likely not using the helps well enough

Notes: Presentation of data that relates to this school. Provide reminder of how the "30" goal data correlates to the state PARCC correlations mentioned previously. Allow & answer questions. Have discussion of how to plan lessons to make 30 achievable. Recommended usage is 60-90 minutes per week. Time for conversation.

Getting Started

- Log in to Clever
  (choose login with Google if needed)
- Click on Applications
- Click on the Imagine Math Icon
- New students are added by administration through clever, not by teacher
- Choose content tab- go to lesson explorer.

Imagine Math

- Students log in to Clever (choose login with Google if needed, use code badges for younger students)
- Click on Applications
- Click on the Imagine Math Icon
- Program should automatically open
- If program does not open the student has not logged into Clever and needs to refresh Clever first

Notes: Teachers log in & go through exploring parts. Use projector & computer to model the process for logging into the Imagine Math/Blueprint. Have peers assist each other.

Benchmark Settings

The beginning of the year benchmark is automatically set up when the student logs in for the first time.

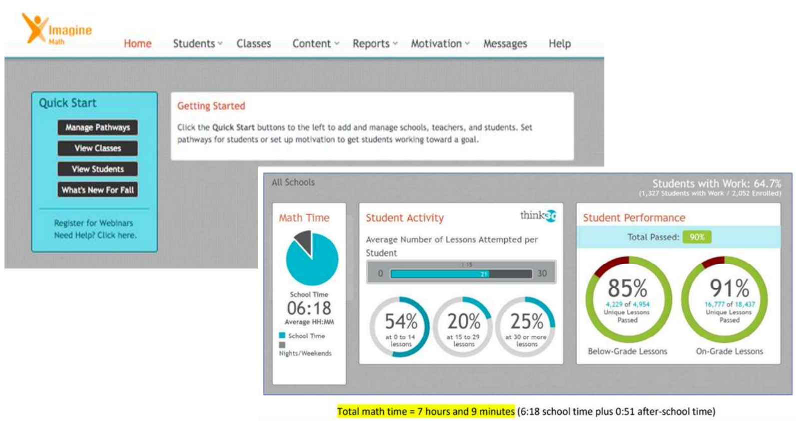
When the benchmark is done the standard path will automatically be set up with remedial areas that have shown up in the benchmark. The teacher can change or add to the pathways.

After 90 days the mid year benchmark will need to be assigned by you (usually late December to early January).

In IM, choose student tab, scroll down to benchmark roster. Click box for checkmark to show up to assign all students or individually choose. If the choice is not available click the letter I by the name for more information about when the benchmark can be given. It has to be at least 90 days after the first benchmark was completed. This will be reviewed again at the next PD.

Notes: Teachers click tab to find benchmark setting. Teachers given access to take benchmark test at their grade level. Allow time for the teachers to answer questions at their grade level so they are familiar with the initial benchmark placement test.

Teacher Dashboard



Notes: Review & Model each of the tabs on the teacher dashboard (home, students, classes, content, reports, motivation, messages, and help). Point out the dashboard sample is from district usage from April 2019 & have participants state data they notice from reading this dashboard. Identify potential things to look for in their own dashboard in the future.

IM Parts of the Lesson

Pre-quiz: Students demonstrate previous knowledge & may place out of lesson (80%)
Warm Up: 3 minute game where students practice procedures & facts that may be relevant to lesson
Guided Learning: Instructional tasks with corrective feedback, tools, interactive glossary, math help, & live teacher access
Problem Solving Process: Practice application (not available on all lessons)
Practice: Students review and apply ideas from guided learning with corrective feedback
Post-quiz: Students need to pass (70%) or possible remedial lesson or repeat of lesson is redone. After a second failure the lesson moves to bottom of pathway

Pre-quiz & problem-solving are options that can be added/eliminated by teacher

Notes: Use modeling to bring up each of the lesson parts from the content tab. Model the lesson parts. Have teachers also open up each part so they can try each of the parts from a sample lesson from their grade level content. Allow volunteers to demonstrate parts if they would like to share.

Scaffolded Features

Multiple representations: Models, symbols, diagrams

Adaptivity and individualization: Lesson paths may change based on student performance. Custom topics & lessons from various grade levels can be assigned. Problems and answers can be read aloud by computer. Spanish is available.

Vocabulary support. Glossary available. Interactive glossary by clicking on underlined words to get automatic definition & visual.

Math tools: Students can use math tools to draw, use fraction bars, & other resources.

Motivational: Provides avatar and points to earn towards avatar purchases, donations to charity, and classroom goals

Outstanding results. Students of all ages and ability levels make great gains IM.

Notes: Provide opportunity to use the scaffolded features. Demonstrate the math tools, calculator, and have teachers try tools and interactive glossary. Make sure to show special features in the Guided Learning section where students have access to two math helps and teacher support.

Motivation Features

Student designed avatar where students can earn coins to purchase avatar accessories

Earn coins, certificates, & badges

Game warm-ups

Donate points to dollars for charity

Donate points to Class Prize

Theme-based contests

Peer interactions

Notes: Model & explore the motivational features including the avatars and store. Explain the requirements needed before setting up the classroom goals. Review the donations. Group discussion on motivational features that seem to work best from prior experience with the program.

Scheduling IM Time

Here are some ideas for how to implement IM/Blueprint:

Dedicate 15-20minutes from math intervention time.

Self-contained classrooms can set up a in math stations, cheetah den, or RTI.

If you have enough computers to make it work, spend the end of every math period on IM.

Assign students to work on IMoutside of class time either in a computer lab or at home. (Difficulty can be a concern for some parents)

Notes: Provide a discussion & sharing time of how IM is being integrated. Allow sharing time of successes and problems with scheduling. Group & Team discussions of current integration times, what’s working & suggestions.

Goals & Expectations

Math communication and problem solving is an area of growth for most of our students. The IM program provides opportunities to improve these skills.

Current state scores have tended to be lower in the modeling and reasoning areas. This program uses these skills. This program also provides many opportunities to use online math tools similar to state test.

Will support the following school goals:

1. 100% of 2rd-6th grade teachers will be trained and implement IM programs as shown through observations and data monitoring.

2. Over 85% of students at each grade level will demonstrate completion of the benchmarks tests within the time frame set by the district.

Notes: Reminder of using benchmarks to monitor achievement and growth using the Quantile system. Show link on website to the Quantile scoring range.

Quantile Ranges

Grade	Far Below Basic	Below Basic	Basic	Proficient	Advanced
2		Below 100	100-215	220-420	425+
3	EM to 130	135-235	240-385	390-770	775+
4	EM to 275	280-385	390-525	530-910	910+
5	EM to 340	345-555	560-685	690-1005	1010+
6	EM to 430	435-675	680-805	810-1075	1080+

Notes: Show IM chart in program and point out where the Quantile ranges correlate with percentile ranges and how to see the ranges for their grade level.

Reports Available

Sign up for weekly email with quick link to reports.

Weekly Progress Summary: shows usage, implementation & performance metrics

Overview: shows view of individual students' usage

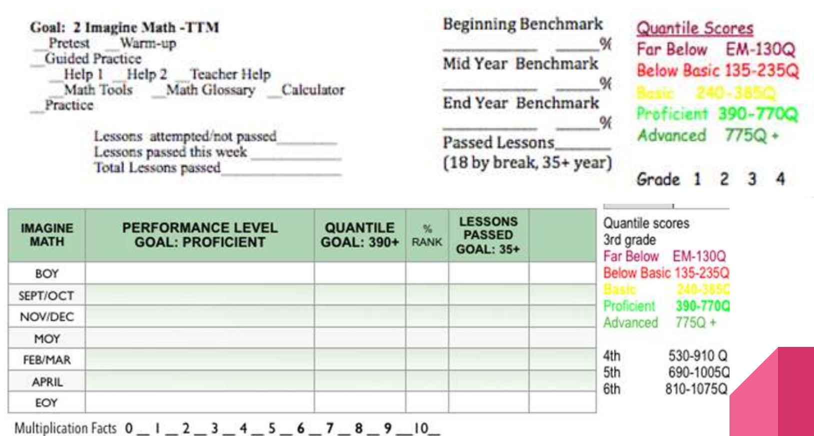
Standards: shows students' progress on state standards

Student Progress: overview of students' progress on personalized pathways

Benchmark: shows benchmark growth and performance with quantile scores and percent

Notes: Model how to open each of the reports. Provide time for discussing best reports for monitoring and strengths of each report. Review each of the reports. Look at parts of report and discuss the Look-fors (low passing rate means not reading or using helps).Show and have participants click option to receive weekly monitoring report through email.

Reporting Stickers & TemplatesCreated


Goal: 2 Imagine Math -TTM
__Pretest __Warm-up
__Guided Practice
__Help 1 __Help 2 __Teacher Help
__Math Tools __Math Glossary __Calculator
__Practice

Lessons attempted/not passed________
Lessons passed this week__________
Total Lessons passed____________

Beginning Benchmark
__________ _____%
Mid Year Benchmark
__________ _____%
End Year Benchmark
__________ _____%
Passed Lessons______
(18 by break, 35+ year)

Quantile Scores
Far Below EM-130Q
Below Basic 135-235Q
Basic 240-385Q
Proficient 390-770Q
Advanced 775Q +

Grade 1 2 3 4

IMAGINE MATH	PERFORMANCE LEVEL GOAL: PROFICIENT	QUANTILE GOAL: 390+	% RANK	LESSONS PASSED GOAL: 35+	
BOY					
SEPT/OCT					
NOV/DEC					
MOY					
FEB/MAR					
APRIL					
EOY					

Multiplication Facts 0__ 1__ 2__ 3__ 4__ 5__ 6__ 7__ 8__ 9__ 10__

Quantile scores
3rd grade
Far Below EM-130Q
Below Basic 135-235Q
Basic 240-385Q
Proficient 390-770Q
Advanced 775Q +

4th 530-910 Q
5th 690-1005Q
6th 810-1075Q

Notes: Show samples of the researcher created stickers for student self-monitoring, teacher-friendly labels that can be placed in agenda weekly for parental communication or in data binder for student progress. Send emails attachments of templates to participants to edit for their own needs. Allow discussion for monitoring features.

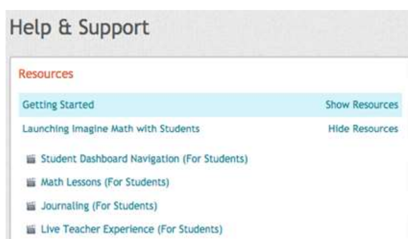
Reflection Questionnaire:

1. Describe your perception of successful integration of math technology.
2. Describe what you think are some of your current strengths for implementing Imagine Math/Blueprint.
3. Describe what you think are some of you current weaknesses for implementing Imagine Math/Blueprint.
4. What do you think will be the effects integration of math technology on student proficiency?
5. How confident are you about your ability to integrate these programs math?
6. What support do you need next?
7. Please clarify any other comments, questions, or concerns.
8. How well are your students using the online tools, helps, teachers, & journaling?

Notes: Have participants respond to evaluation questions that can be used for adjusting future PD related to the programs.

IM Self-Paced Video Tutorials Available

Click the help tab in IM –
Choose Launching IM with Students
Student Dashboard Navigation provides a video for teachers to show students prior to beginning.
Click the link to imagine Math University to get access to the self-paced video tutorials.



Tutorials Available:

Imagine Math:	getting started
	student experience
	reports and data
	teacher resources
	teacher to teacher (best practices)
Blueprint:	getting started
	student experience

Notes: here is list of IM self-paced videos under the IM Help Tab that are available for staff to use during repetitive pieces of PD or at their own convenience for additional support.

Reflex Math

A math facts fluency program to develop automaticity

Resources

All information has been retrieved from: https://www.reflexmath.com/research

Cholmsky, P. (2011). From acquisition to automaticity: The Reflex solution for math fact mastery. Retrieved February 12, 2017, from Reflex, https://www.reflexmath.com/assets/doc/Reflex_White_Paper.pdf

Notes: Introduce Reflex as a math facts fluency program that is being brought back to the school and district.

Data

Many have asked to returnReflex because all the teachers have noticed that students do not have mastery of their basic facts, this is hindering their ability to perform math in a reasonable amount of time, and staff said this program was better than IM facts to meet these needs.

Research shows that fact fluency is a significant predictor of performance on standardized tests.

Notes: Can show the white paper data available on the site. Explain there is no current local data to view because Reflex was discontinued in fall of 2018 when IM Facts was being tested.

Key Features

•**Adaptivity and individualization.** Reflex continuously monitors each student's performance to create the optimal experience for every child. Provides practice on previously mastered facts while introducing new facts through fact family and commutative property methods.
•**Intuitive and powerful reporting.** Educators have everything they need to easily monitor and support student progress in Reflex. Fluency and green lights are recorded. Certificates for goals are available.
•**Anytime, anywhere access.** Students have access to Reflex anywhere there is an Internet connection.
•**Fun!** Reflex is game-based and highly motivational so students enjoy the learning process. There are several games that students can choose from. Students earn tokens and can purchase items for their avatar or tree house. Games increase in difficulty and speed of play and offer fact choices for students to answer. Store opens after a green light is chosen. Students have access to two games initially & need to earn green lights to open other games.
• **Results.** Students of all ages and ability levels make great gains with Reflex.

Notes: Speak to the key features and the three available pathways. The program is available for students in the 1st grade if they are proficient enough to type in numbers and ready for a program based on improving fluency.

Getting Started

•Log in to Clever
(choose login with Google if needed)
•Click on Applications

•Click on the Reflex Icon

•New students are added by administration through clever, not by teacher

•Choose student experience

•Students log in to Clever (choose login with Google if needed)

•Click on Applications

•Click on the Reflex Icon

•Program should automatically open

•If program does not open the student has not logged into Clever and needs to refresh Clever first

Notes: Model the process of logging in with projector screen. Have teachers use own computers to log in. Teachers can have the experience of trying the different parts of the program. This may prompt questions to answer.

Individual & Adaptive Features

The system is based on a fact family approach that builds on and reinforces important mathematical concepts such as the commutative property and the relationship between the operations. Understanding the conceptual connections between facts will improve automaticity.

Reflex is highly adaptive and individualized so that students of all ability levels have early and ongoing success. Students type numbers before beginning to make sure they can type fast enough but also be given the right amount of response time for their typing. The system consistently rewards students for both their effort and progress.

Reflex fluency development games are different. Unlike typical math fact games, they require students to engage in increasingly complex and fast-paced decision making.

Reflex is continually improving based on detailed analysis of student response patterns.

Notes: Have students log in to do a sample lesson and experience the individual and adaptive features first hand for better understanding. This will show amount of work to get a green light and give access to the Reflex store for avatar & tree accessories.

Parts of Student Experience

Crabby's Fact Fair: The first time students log in they are greeted outside by Crabby who will provide instructions and a fluency check. Students develop facts by typing in the numbers in open number sentences.

Coaching: The first part is a short study segment where the new facts are presented and then practiced by the student. When a student clicks on a game, Coach Penny gets students ready to play the fluency development games by teaching them new facts and families. Exactly what Coach Penny teaches on a given day depends on what an individual student needs. Picture puzzles introduce speed of retrieval for facts and are used to monitor and support automaticity. Facts with stabilized patterns are used in games.

Game Practice: Fluency development games are a set of fun, yet challenging games students play to help build automaticity. Students are supposed to earn green lights by correctly answering enough fact questions each day.

Green Light notes: Green lights are achieved only once per day. If some students do not reach the Daily Usage Requirement in their first session of the day, they can log in later to finish. · Students can typically get to the Green Light in 15 minutes of concentrated use. Students new to Reflex may take longer at first as they are mastering the different games, but the time should go down with continued use. For students that are struggling to reach the Green Light within the time available, thegames Ninja to the Stars, Egyptian Conniption, and Swamp Chomper aresuggested since many facts can be solved very quickly. · New games are unlocked based on green lights.

Notes: Point out the focuses of each of the student experience parts. Have teachers try each of these parts. Allow time for questions and conversations about experience. During the coaching, note that you can have students write down their focus facts in their data binder, agenda, or other form.

Adjustable Label Sticker Templates

Data Monitoring chart

Multiplication Facts 0 __ 1 __ 2 __ 3 __ 4 __ 5 __ 6 __ 7 __ 8 __ 9 __ 10 __

Math Fluency Data

MATH FLUENCY PER MIN	ADD/SUBT (242)	MULT/DIV (242)	MULT/ DIV (325)
BOY			
October			
Dec (+/- done)			
February			
April			

Template for monitoring Reflex

Goal: 3 Green Lights
Reflex: ___Add/Sub ___ Mult/Div

Green Lights (S) (S) (M) (T) (W) (T) (F)

Picture Puzzles Only (M) (T) (W) (T) (F)

Focus Facts ____________________

Focus Facts ____________________

Notes: Show sample researcher created forms that can be used on daily, weekly, and monthly basis to monitor progress or report to parents. Email templates of each for to participants to adjust for their own grade level and needs.

Scheduling Reflex Time

Here are some ideas for how to implement Reflex:

Dedicate 15 minutes from math intervention time.

Self-contained classrooms can set up a math facts station.

If you have enough computers to make it work, spend the beginning or end of every math period on Reflex.

Assign students to work on Reflex outside of class time either in a computer lab or at home. Access is easy and the program is user-friendly.

Notes: Provide time for discussions with groups: ask for people to share different ways they have integrated Reflex & the strengths/weaknesses of their choices.

Expectations & Goals

Math fact fluency is the quick and effortless (automatic) recall of basic math facts. When students achieve automaticity with these facts, they have attained a level of mastery that enables them to retrieve them from long-term memory without conscious effort or attention.

Current national goals have included fact fluency as an elementary goal because of its correlation with mathematics achievement scores.

Will support the following goals:

1. 100% of 2nd-6th grade teachers will be trained to implement the Reflex as shown through observations and data monitoring.

2. Over 85% of students at each grade level will take the benchmark placement at the beginning of the year and work toward proficiency of math facts by getting green lights on the Reflex computer program at least two times per week.

Notes: Suggested usage is for 3 green lights per student each week. Students can continue work at home or at different times. Only one green light per day. Reminder that goals are to get the PD needed and give preliminary benchmarks at beginning of year. Allow conversations about grades and the different goals of adding/subtracting, multiply /divide to 10, multiply & divide to 12

Motivational Features

Accessories store only opens after the student reaches a green light. Only one green light can be earned each day. Fact practice (toward 250 facts goal) begins new each day.

Students can design their avatar and can earn coins to purchase avatar accessories

Earn coins, certificates, access to new games

Game oriented

Fact tree house with features that can be purchased

Choice of games

Notes: Reminder of games for Ninja to the Stars, Egyptian Conniption, and Swamp Chomper can be used to get to the green light faster. Students will have to retype facts each time they log in. They may also need to finish the picture puzzles.

Dashboard

Dashboard shows overall class progress toward fluency

Dashboard shows access to individual and class information and reports

- alerts, milestones, progress
- summary fluency levels, growth,
- relationship between usage and gains

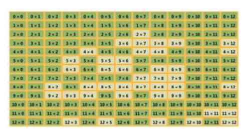
Notes: The teacher dashboard shows at what percent the class is towards reaching the goal of fluency. The dashboard also provides alerts, milestones and certificate notices for the teacher to be aware of.

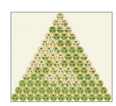
Reports Available

Group Report: shows initial assessment, percent fluency, fluency gain in last 2 weeks, usage over last 2 weeks and date of last login

Fact Detail: shows which facts have been mastered

Milestones: shows certificates that have been earned





Usage Detail: shows days & time spent on reflex; also shows green lights earned

Fluency Growth: shows graph of fluency gain

Dashboard: shows percent fluency for class, usage alerts, and milestones reached

Notes: Have students look at each of the reports and compare their information. Students have access to the Fact Detail Reports which color learned facts in with a dark green background.

Reflection Questionnaire:

1. Describe your perception of successful integration of math technology.
2. Describe what you think are some of your current strengths for implementing Reflex.
3. Describe what you think are some of you current weaknesses for implementing Reflex.
4. What do you think will be the effects integration of math technology on student proficiency?
5. How confident are you about your ability to integrate these programs math?
6. What support do you need next?
7. Please clarify any other comments, questions, or concerns.

Notes: Collect reflection data to use for adjusting the follow-up professional development.

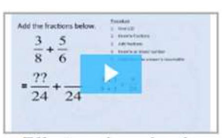
NCTM Video support provided by Reflex

found at http://www.reflex .com

Working memory


Automaticity and the brain

Automaticity and the brain



Effect on learning in mathematics


Why Reflex games work


Motivation

Paul Cholmsky

Notes: Here is list of Reflex videos about the brain and automaticity that are available for staff to use during repetitive pieces of PD or at their own convenience for additional support.

Below are the handouts created by the researcher to create individual pathways for students.

Login to Imagine Math -Think Through Math

Content Tab
Click **Manage Pathways**

Identify a pathway - (one cluster) - and choose the action **Clone**

Rename (put cluster, with cues - remedial, enriched, with no pretest)
Choose **Save**

Choose the grade level you want to be shown

Check Pathways options
Benchmark remediation - based on benchmark
Use pathway remediation - (will fall back on lessons based on scores)
Skip problem solving process
Allow test out (80% on prequiz will allow skipping lesson if you want this choice)
Require Prequiz (means there is no option to skip prequiz-
You may want to skip prequiz for students who need the lesson)

Filter Grade level- choose a lower grade for remedial grade level lessons,
a higher grade level for enrichment or
leave at current grade level

First Column (choose green plus to add the lesson to your pathways)
Second Column (choose red X to remove lesson from your pathway)
Second Column (click lesson and scroll up or down to change order of pathway lessons)

Choose blue save button near top

Lesson will appear under custom lessons

ASSIGNING LESSONS
Classes-active classes
Current students
Put checkmarks by student names
Click assign pathway

Choose custom lessons tab
Pick lesson
Assign pathway/save

Refresh tab to confirm lesson was assigned

Under Help

- Math Resources
  - Grade level performance tasks & stem activities
  - Guided Learning graphic organizes
  - Math journaling

Content

- Lesson explorer-to view a lesson
- Choose grade level (search)
  - Pick lesson
  - Scroll to bottom to preview
    - Click arrow to find what part of lesson to preview
      - Prequiz-optional depending on choice
      - Warm-up- game to support content
      - Guided lesson-only place to get math help & teacher help
      - Practice-
      - Post-quiz-often repeat questions from guided & practice

List of current lessons to use to set up and create individualized lessons and pathways with that can include multiple grade levels.

NWEA Breakdown of lessons by Grade for setting up customized paths

Grade 1
Building Ten
Visualizing Whole Numbers
Visualizing Addition
Tens and Ones
Visualizing Subtraction
Adding Ones
Adding and Subtracting within 10
Adding and Subtracting 10
Adding and Subtracting within 20
Subtracting Tens
Structuring Within 5 and Composing 10
Visualizing Place Value
Structuring Within 10
Structuring Within 20
Concepts of Addition and Subtraction
Understanding Addition and Subtraction Problems
Relationship Between Addition and Subtraction
Relating Addition and Subtraction With Models
Strategies for Addition and Subtraction Facts

Grade 2

Strategies for Addition and Subtraction Facts II
Adding and Subtracting within 100
Money Sense With Coins
Understanding 3-Dimensional Figures
Equal Parts I
Making Equal Groups I
Structuring Within 100
Money Sense With Coins and Bills
Making Equal Groups II
Making Groups of Hundreds and Tens
Understanding Data Displays
Equal Parts II
Whole Numbers and Place Value I
Whole Numbers and Place Value II
Three-digit Number Representations
Whole Number Comparisons
Addition and Subtraction with 10 and 100
Reasoning About Addition and Subtraction with 10 and 100
Addition Regrouping Concepts
Subtraction Regrouping Concepts
Strategies for Adding and Subtracting
Strategies for Adding and Subtracting
Adding and Subtracting within 1,000

Grade 3

Visualizing Addition and Subtraction
Structuring Within 1,000
Unit Squares
Classifying Quadrilaterals I
Visualizing Multiplication and Division
Concept of Multiplication - Grouping
Multiplying by Multiples of Ten
Reasoning About Place Value and Rounding
Concept of Area
Area of Rectangles
Concept of Multiplication - Word Problems
Rounding to the Nearest Ten and Hundred
Recognizing Area as Additive
Concept of Multiplication - Arrays
Reasoning About Addition and Subtraction within 1,000
Area of Basic Composite Figures
Properties of Addition and Multiplication
Perimeter
Understanding Fractions - Equal Areas
Concept of Division
Understanding Fractions - Notation
Capacity or Weight
Interpreting Division Problems
Unit Fractions on the Number Line
Money Sense
Constructing Division Problems
Fractions on the Number Line
Adding and Subtracting Time
Relationship Between Multiplication and Division
Modeling Equivalent Fractions with Number Lines
Introduction to Data Displays
Multiplication and Division Fact Families
Measurement & Geometry Data
Visual Models of Equivalent Fractions
Solving Multiplication and Division Equations
Whole Numbers as Fractions
Division as an Unknown-Factor Problem
Whole Numbers as Fractions on the Number Line

Grade 3 continued

Multiplication and Division Word Problems - Visual Models
Comparing Fractions with the Same Numerator or Denominator
Multiplication and Division Word Problems - Equations
Recognizing Valid Fraction Comparisons I
Multiplication and Division Word Problems - Solutions
Understanding Fractions - Relationship Between Numerator and Denominator
Estimating Sums and Differences - Application
Solving Two-Step Word Problems
Modeling and Solving Two-Step Word Problems
Using Visual Models to Understand the Distributive Property
Additive and Multiplicative Patterns
Developing Fluency Using 2 as a Factor
Developing Fluency Using 5 or 10 as a Factor

Grade 4

Using Halves and Doubles to Solve Multiplication Problems
Visualizing Place Value Relationships
Area and Perimeter of Rectangles
Identifying and Classifying Lines, Rays, and Segments
Classifying Triangles
Multiplication as a Comparison - Equations
Visualizing Rounding
Identifying and Comparing Angles
Multiplication as a Comparison - Word Problems
Adding Whole Numbers
Angles
Classifying Quadrilaterals II
Interpreting Remainders
Adding and Subtracting with the Standard Algorithm
Units of Measure - Customary
Symmetry
Using Equations to Model and Solve Multi-step Problems
Place Value Concepts
Units of Measure - Metric
Factors
Using Place Value Concepts to Compare Whole Numbers
Relating Factors and Multiples I
Relating Factors and Multiples II
Generating and Describing Number Patterns
Understanding Place Value Relationships
Rounding Whole Numbers
Using Rounding in Problem Solving Multiplying Whole Numbers
Multiplying 2-Digit Numbers by 2 Digit Numbers
Dividing Multiples of Ten
Dividing by Tens
Dividing Whole Numbers - One-Digit Divisors
Estimating Solutions to Multi-step Word Problems
Modeling Equivalent Fractions
Generating Equivalent Fractions
Reducing Fractions
Comparing Fractions - Visual Models
Comparing Fractions with Different Numerators and Different Denominators
Recognizing Valid Fraction Comparisons II

Grade 4 continued

Adding and Subtracting Fractions with Like Denominators
Adding and Subtracting Fractions with Like Denominators in Real World Situations
Decomposing Fractions and Mixed Numbers
Writing Fractions as Mixed Numbers and Mixed Numbers as Fractions
Word Problems with Fractions and Mixed Numbers - Visual Models
Word Problems with Fractions and Mixed Numbers - Estimation
Adding and Subtracting Mixed Numbers with Like Denominators - Conceptual
Strategies Adding and Subtracting Mixed Numbers with Like Denominators
Multiplying Unit Fractions by Whole Numbers
Multiplying Fractions by Whole Numbers
Solving Word Problems with Multiplication of Fractions by Whole Numbers
Understanding Fractions with Denominators of 10 and 100
Adding Fractions with Denominators of 10 or 100
Comparing Decimal Fractions
Comparing and Ordering Decimal Fractions
Decimal Notation I
Decimal Notation II
Decimals to Hundredths
Introduction to Comparing Decimals to Hundredths
Comparing Decimals to Hundredths
Recognizing Valid Decimal Comparisons
Fraction and Decimal Equivalents Comparing Fractions and Decimals

Grade 5

Evaluating Simple Expressions
Operations with Whole Numbers - Mixed Practice
Volume of Rectangular Prisms I
Introduction to the Coordinate Plane
Writing Simple Expressions
Geometry
Volume of Rectangular Prisms II
Multiplying Whole Numbers - Standard Algorithm
Representing Real-World Quantities in the First Quadrant
Writing and Interpreting Simple Expressions
Line Plots
Classifying 2 Dimensional Figures
Multiplying 3-digit by 2 digit Whole Numbers Using the Standard Algorithm
Dividing Whole Numbers - Two-Digit Divisors
Understanding Fractions as Division
Adding Fractions
Adding Fractions - Estimation Strategies
Subtracting Fractions
Subtracting Fractions - Estimation Strategies
Understanding Products with Fractions
Multiplying Fractions by Fractions
Multiplying with Fractions and Mixed Numbers
Adding and Subtracting Fractions
Adding and Subtracting Fractions - Multi-step Word Problems
Multiplying Fractions by Whole Numbers to Solve Multistep Problems
Dividing Unit Fractions by Whole Numbers
Dividing Whole Numbers by Unit Fractions
Decimals to Thousandths
Comparing Decimals to Thousandths
Rounding Decimals to the Nearest Tenth and Hundredth
Reasoning About Rounding Decimals
Adding and Subtracting Decimals
Adding and Subtracting Decimals in Real-World Situations
Multiplying by Powers of Ten
Dividing by Powers of Ten
Multiplying and Dividing by Powers of Ten

Grade 5 continued

Place Value Relationships Within Whole Numbers and Decimals
Multiplying Decimals to Hundredths
Dividing Decimals to Hundredths
Using Reasoning and Estimation to Calculate with Decimals
Calculating with Decimals

Think Thru Math Lessons

Lessons	Scores	
1) Visualizing Whole Numbers		
2) Visualizing Place Value		
3) Visualizing Addition		
4) Visualizing Subtraction		
5) Structuring within 5,Composing 10		
6) Structuring within 10		
7) Structuring within 20		
8) Structuring within 100		
9) Structuring within 1,000		
!0) Concept of Multiply-Grouping		

Think Thru Math Lessons-1

Lessons	Scores	
1) Mult. & Div. Word problem-Visual		
2) Mult.&Div. Word problem-Equation		
3) Mult. & Div. Word problem-Solution		
4)Mult. by Multiples of Ten		
5)Reasoning about PlaceValue & Round		
6)Rounding to Nearest Ten/Hundred		
7)Estimating Sums/Differences App		
8)Reasoning about Add.&Sub W/in 1000		
9)Solving two-step word problems		
!0)Model& Solve two-step word prob		

Think Thru Math Lessons-2

Lessons	Scores	
1) Concept of Multiply-Word Problem		
2) Concept of Multiply - Array		
3) Properties of Add & Multiply		
4) Concept of Division		
5) Interpreting Division Problems		
6) Constructing Division Problems		
7) Relationship between Mult & Div		
8) Mult. & Div. Fact Families		
9) Solving Mult. & Div. Equations		
!0) Division as Unknown-Factor		

Think Thru Math Lessons-3

Lessons	Scores	
1) Understanding Fractions-equal areas		
2)Understanding Fractions-notation		
3)Unit fraction on the number line		
4)Fractions on the number line		
5)Modeling Equivalent fract with # line		
6)Visual Models of Equivalent Fractions		
7)Whole numbers as fractions		
8)Whole numbers as fractions on # line		
9)Compare fractions with same num/den		
!0)recognizing valid fraction comparison		

Think Thru Math Lessons-4

Lessons	Scores	
1) Unit Squares		
2)Concept of Area		
3)Area of rectangles		
4)Recognizing Area as Additive		
5)Using Visual Models Distributive Prop.		
6)Area of Basic Composite Figures		
7)Perimeter		
8)Classifying Quadrilaterals		
9)Capacity or Weight		
!0)Money Sense		

Think Thru Math Lessons-6

Lessons	Scores	
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
9)		
!0)		

Think Thru Math Lessons-5

Lessons	Scores	
1) Adding & Subtracting Time		
2) Intro to Data Displays		
3) Additive & Multiplicative Patterns		
4)		
5)		
6)		
7)		
8)		

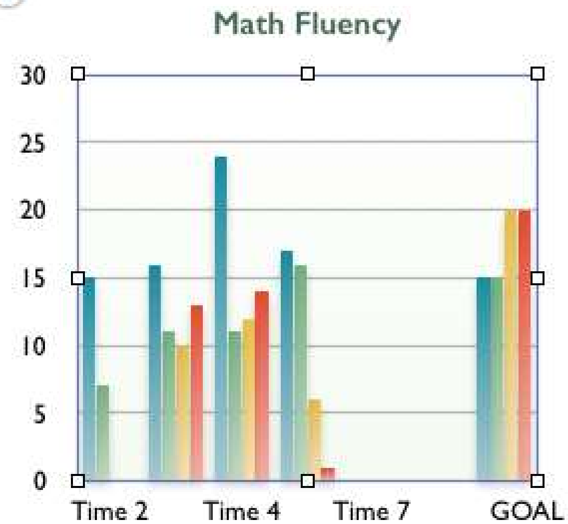
Think Thru Math Lessons-7

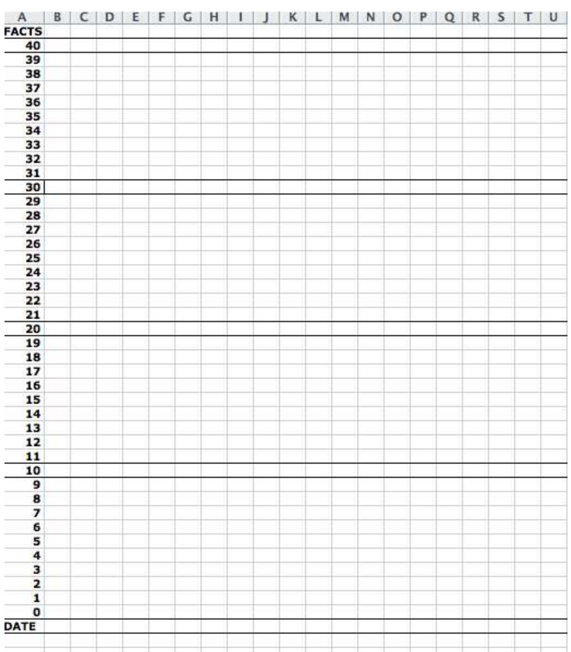
Lessons	Scores	
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		

Sample graphing charts set up on pages for student to graph progress with Reflex. First one-Students fill in their data and the colored graph shows their progress. Second chart student colors bar graph over time to show progress

Math Fluency Data

MATH FLUENCY	DD +	DD-	X	÷
Baseline	15	7	0	0
Time 2	16	11	10	13
Time 3	24	11	12	14
Time 4	17	16	6	1
Time 5				
Time 6				
GOAL	15	15	20	20





Basic Journal Format to use with IM

Student copies the help information, vocabulary words and other supports. Makes own visual representation to the problem and tries to follow models provided. Easy to have students just draw the t-quadrant in a math notebook to keep work journal over time.

Copy information from Math Help 1	Copy information from Math Help 2
Notes from glossary, teacher, tools	Now make your own visual to represent the problem

Sample Pages teacher report for showing progress of entire class on given goal. Can be printed or displayed by projector.

Third Grade Math Fluency

Third Graders need to be able to solve 20 multiplication and division facts in one minute.

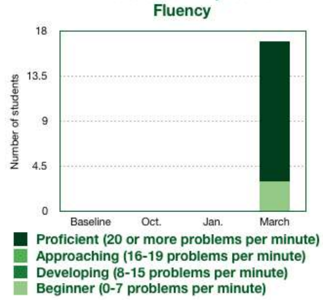
Multiplication

	Baseline	Oct.	Jan.	March
Beginner (0-7 problems per minute)				3
Developing (8-15 problems per minute)				
Approaching (16-19 problems per minute)				
Proficient (20 or more problems per minute)	0			14

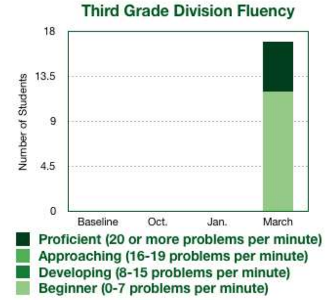
Division

	Baseline	Oct.	Jan.	March
Beginner (0-7 problems per minute)				12
Developing (8-15 problems per minute)				
Approaching (16-19 problems per minute)				
Proficient (20 or more problems per minute)	0			5

Third Grade Multiplication Fluency



Third Grade Division Fluency



Third Grade Math Fluency

By June 2010, all third grade students will compute 30 addition and 30 subtraction problems in one minute with 100% accuracy .

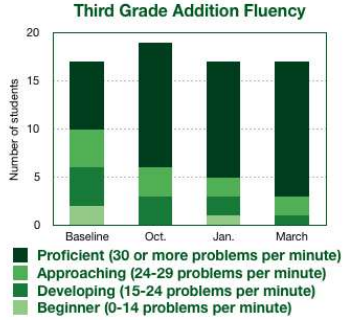
Addition

	Baseline	Oct.	Jan.	March
Beginner (0-14 problems per minute)	2	0	1	0
Developing (15-24 problems per minute)	4	3	2	1
Approaching (24-29 problems per minute)	4	3	2	2
Proficient (30 or more problems per minute)	7	13	12	14

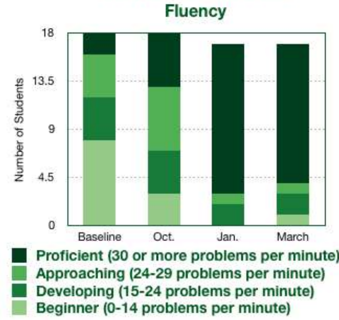
Subtraction

	Baseline	Oct.	Jan.	March
Beginner (0-14 problems per minute)	8	3	0	1
Developing (15-24 problems per minute)	4	4	2	2
Approaching (24-29 problems per minute)	4	6	1	1
Proficient (30 or more problems per minute)	2	5	14	13

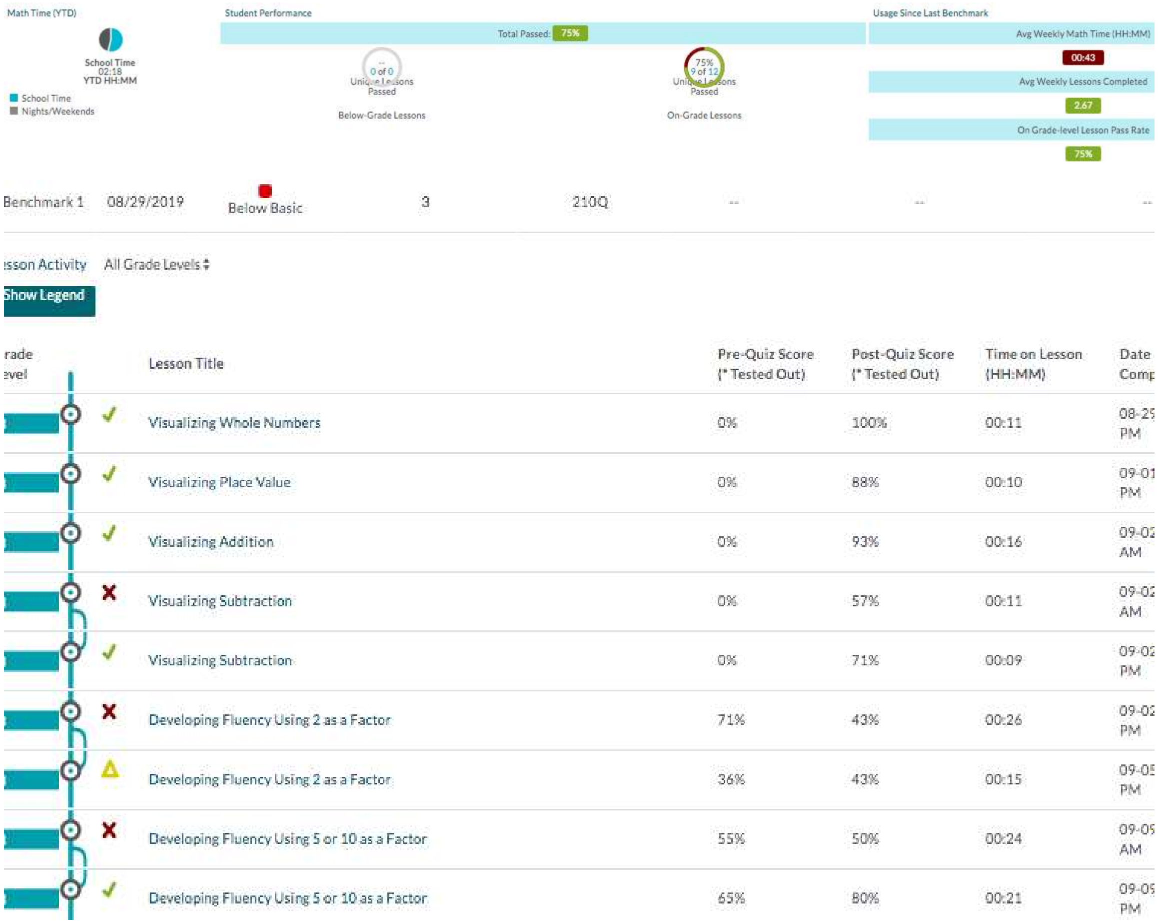
Third Grade Addition Fluency



Third Grade Subtraction Fluency



Sample visuals of progress report that teacher should look at for own student that shows beginning benchmark, time spent on program, average lessons passed and scores on specific lessons. All report features should be discussed for their usage and planning.



rade evel		Lesson Title	Pre-Quiz Score (* Tested Out)	Post-Quiz Score (* Tested Out)	Time on Lesson (HH:MM)	Date Comp
	✓	Visualizing Whole Numbers	0%	100%	00:11	08-29 PM
	✓	Visualizing Place Value	0%	88%	00:10	09-01 PM
	✓	Visualizing Addition	0%	93%	00:16	09-02 AM
	✗	Visualizing Subtraction	0%	57%	00:11	09-02 AM
	✓	Visualizing Subtraction	0%	71%	00:09	09-02 PM
	✗	Developing Fluency Using 2 as a Factor	71%	43%	00:26	09-02 PM
	△	Developing Fluency Using 2 as a Factor	36%	43%	00:15	09-05 PM
	✗	Developing Fluency Using 5 or 10 as a Factor	55%	50%	00:24	09-09 AM
	✓	Developing Fluency Using 5 or 10 as a Factor	65%	80%	00:21	09-09 PM

Editable sticker templates that can be used for students to fill in for personal data binders on progress for general path lessons. Students keep track of own lessons and scores. Sample shown is for one grade level of 45 lessons. The first two pages contain 10 sets of 5 lessons. The next 4 contain 5 sets of 10 lessons since students tend to take longer to get through lessons 11-45.

Beginning Benchmark ________ ____% Mid Year Benchmark ________ ____% End Year Benchmark ________ ____% Passed Lessons______ (18 by break, 35+ year)	Quantile Scores Far Below EM-130Q Below Basic 135-235Q Basic 240-385Q Proficient 390-770Q Advanced 775Q + Grade 1 2 3 4	Beginning Benchmark ________ ____% Mid Year Benchmark ________ ____% End Year Benchmark ________ ____% Passed Lessons______ (18 by break, 35+ year)	Quantile Scores Far Below EM-130Q Below Basic 135-235Q Basic 240-385Q Proficient 390-770Q Advanced 775Q + Grade 1 2 3 4
Beginning Benchmark ________ ____% Mid Year Benchmark ________ ____% End Year Benchmark ________ ____% Passed Lessons______ (18 by break, 35+ year)	Quantile Scores Far Below EM-130Q Below Basic 135-235Q Basic 240-385Q Proficient 390-770Q Advanced 775Q + Grade 1 2 3 4	Beginning Benchmark ________ ____% Mid Year Benchmark ________ ____% End Year Benchmark ________ ____% Passed Lessons______ (18 by break, 35+ year)	Quantile Scores Far Below EM-130Q Below Basic 135-235Q Basic 240-385Q Proficient 390-770Q Advanced 775Q + Grade 1 2 3 4
Beginning Benchmark ________ ____% Mid Year Benchmark ________ ____% End Year Benchmark ________ ____% Passed Lessons______ (18 by break, 35+ year)	Quantile Scores Far Below EM-130Q Below Basic 135-235Q Basic 240-385Q Proficient 390-770Q Advanced 775Q + Grade 1 2 3 4	Beginning Benchmark ________ ____% Mid Year Benchmark ________ ____% End Year Benchmark ________ ____% Passed Lessons____ (18 by break, 35+ year)	Quantile Scores Far Below EM-130Q Below Basic 135-235Q Basic 240-385Q Proficient 390-770Q Advanced 775Q + Grade 1 2 3 4
Beginning Benchmark ________ ____% Mid Year Benchmark ________ ____% End Year Benchmark ________ ____% Passed Lessons______ (18 by break, 35+ year)	Quantile Scores Far Below EM-130Q Below Basic 135-235Q Basic 240-385Q Proficient 390-770Q Advanced 775Q + Grade 1 2 3 4	Beginning Benchmark ________ ____% Mid Year Benchmark ________ ____% End Year Benchmark ________ ____% Passed Lessons____ (18 by break, 35+ year)	Quantile Scores Far Below EM-130Q Below Basic 135-235Q Basic 240-385Q Proficient 390-770Q Advanced 775Q + Grade 1 2 3 4
Beginning Benchmark ________ ____% Mid Year Benchmark ________ ____% End Year Benchmark ________ ____% Passed Lessons______ (18 by break, 35+ year)	Quantile Scores Far Below EM-130Q Below Basic 135-235Q Basic 240-385Q Proficient 390-770Q Advanced 775Q + Grade 1 2 3 4	Beginning Benchmark ________ ____% Mid Year Benchmark ________ ____% End Year Benchmark ________ ____% Passed Lessons____ (18 by break, 35+ year)	Quantile Scores Far Below EM-130Q Below Basic 135-235Q Basic 240-385Q Proficient 390-770Q Advanced 775Q + Grade 1 2 3 4

Lesson	score	
1) Visualizing Whole Numbers		
2) Visualizing Place Value		
3) Visualizing Addition		
4) Visualizing Subtraction		
5) Developing Fluency using 2 as factor		

Lesson	score	
1) Visualizing Whole Numbers		
2) Visualizing Place Value		
3) Visualizing Addition		
4) Visualizing Subtraction		
5) Developing Fluency using 2 as factor		

Lesson	score	
6) Developing Fluency using 5 or 10 as factor		
7) Using Halves & Doubles to solve Multiplication Problems		
8) Concept of Multiplication-Grouping		
9) Concept of Multiplication-Word Problems		
10) Concept of Multiplication-Arrays		

Lesson	score	
6) Developing Fluency using 5 or 10 as factor		
7) Using Halves & Doubles to solve Multiplication Problems		
8) Concept of Multiplication-Grouping		
9) Concept of Multiplication-Word Problems		
10) Concept of Multiplication-Arrays		

Lesson	score	
1) Visualizing Whole Numbers		
2) Visualizing Place Value		
3) Visualizing Addition		
4) Visualizing Subtraction		
5) Developing Fluency using 2 as factor		

Lesson	score	
1) Visualizing Whole Numbers		
2) Visualizing Place Value		
3) Visualizing Addition		
4) Visualizing Subtraction		
5) Developing Fluency using 2 as factor		

Lesson	score	
6) Developing Fluency using 5 or 10 as factor		
7) Using Halves & Doubles to solve Multiplication Problems		
8) Concept of Multiplication-Grouping		
9) Concept of Multiplication-Word Problems		
10) Concept of Multiplication-Arrays		

Lesson	score	
6) Developing Fluency using 5 or 10 as factor		
7) Using Halves & Doubles to solve Multiplication Problems		
8) Concept of Multiplication-Grouping		
9) Concept of Multiplication-Word Problems		
10) Concept of Multiplication-Arrays		

Lesson	score	
1) Visualizing Whole Numbers		
2) Visualizing Place Value		
3) Visualizing Addition		
4) Visualizing Subtraction		
5) Developing Fluency using 2 as factor		

Lesson	score	
1) Visualizing Whole Numbers		
2) Visualizing Place Value		
3) Visualizing Addition		
4) Visualizing Subtraction		
5) Developing Fluency using 2 as factor		

Lesson	score	
6) Developing Fluency using 5 or 10 as factor		
7) Using Halves & Doubles to solve Multiplication Problems		
8) Concept of Multiplication-Grouping		
9) Concept of Multiplication-Word Problems		
10) Concept of Multiplication-Arrays		

Lesson	score	
6) Developing Fluency using 5 or 10 as factor		
7) Using Halves & Doubles to solve Multiplication Problems		
8) Concept of Multiplication-Grouping		
9) Concept of Multiplication-Word Problems		
10) Concept of Multiplication-Arrays		

Lesson	score	
1) Visualizing Whole Numbers		
2) Visualizing Place Value		
3) Visualizing Addition		
4) Visualizing Subtraction		
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Lesson	score	
1) Visualizing Whole Numbers		
2) Visualizing Place Value		
3) Visualizing Addition		
4) Visualizing Subtraction		
5) Developing Fluency using 2 as factor		

Lesson	score	
6) Developing Fluency using 5 or 10 as factor		
7) Using Halves & Doubles to solve Multiplication Problems		
8) Concept of Multiplication-Grouping		
9) Concept of Multiplication-Word Problems		
10) Concept of Multiplication-Arrays		

Lesson	score	
6) Developing Fluency using 5 or 10 as factor		
7) Using Halves & Doubles to solve Multiplication Problems		
8) Concept of Multiplication-Grouping		
9) Concept of Multiplication-Word Problems		
10) Concept of Multiplication-Arrays		

Lesson	score	
1) Visualizing Whole Numbers		
2) Visualizing Place Value		
3) Visualizing Addition		
4) Visualizing Subtraction		
5) Developing Fluency using 2 as factor		

Lesson	score	
1) Visualizing Whole Numbers		
2) Visualizing Place Value		
3) Visualizing Addition		
4) Visualizing Subtraction		
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Lesson	score	
6) Developing Fluency using 5 or 10 as factor		
7) Using Halves & Doubles to solve Multiplication Problems		
8) Concept of Multiplication-Grouping		
9) Concept of Multiplication-Word Problems		
10) Concept of Multiplication-Arrays		

Lesson	score	
6) Developing Fluency using 5 or 10 as factor		
7) Using Halves & Doubles to solve Multiplication Problems		
8) Concept of Multiplication-Grouping		
9) Concept of Multiplication-Word Problems		
10) Concept of Multiplication-Arrays		

Lesson	score	
11) Concept of Division		
12) Interpreting Division Problems		
13) Constructing Division Problems		
14) Relationship Between Multiplication & Division		
15) Multiplication & Division Fact Families		

Lesson	score	
16) Solving Multiplication & Division Equations		
17) Division as an Unknown-Factor		
18) Adding & Subtracting Time		
19) Reasoning about Place Value & Rounding		
20) Rounding to the Nearest Ten & Hundred		

Lesson	score	
21) Multiplication & Division Word Problems-Visual Models		
22) Multiplication & Division Word Problems-Equations		
23) Multiplication & Division Word Problems-Solutions		
24) Multiplying by Multiples of ten		
25) Additive & Multiplicative Patterns		

Lesson	score	
26) Unit Squares		
27) Concept of Area		
28) Area of Rectangles		
29) Recognizing Area as Additive		
30) Area of Basic Composite Figures		

Lesson	score	
11) Concept of Division		
12) Interpreting Division Problems		
13) Constructing Division Problems		
14) Relationship Between Multiplication & Division		
15) Multiplication & Division Fact Families		

Lesson	score	
16) Solving Multiplication & Division Equations		
17) Division as an Unknown-Factor		
18) Adding & Subtracting Time		
19) Reasoning about Place Value & Rounding		
20) Rounding to the Nearest Ten & Hundred		

Lesson	score	
21) Multiplication & Division Word Problems-Visual Models		
22) Multiplication & Division Word Problems-Equations		
23) Multiplication & Division Word Problems-Solutions		
24) Multiplying by Multiples of ten		
25) Additive & Multiplicative Patterns		

Lesson	score	
26) Unit Squares		
27) Concept of Area		
28) Area of Rectangles		
29) Recognizing Area as Additive		
30) Area of Basic Composite Figures		

Lesson	score	
11) Concept of Division		
12) Interpreting Division Problems		
13) Constructing Division Problems		
14) Relationship Between Multiplication & Division		
15) Multiplication & Division Fact Families		

Lesson	score	
16) Solving Multiplication & Division Equations		
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Lesson	score	
26) Unit Squares		
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Lesson	score	
11) Concept of Division		
12) Interpreting Division Problems		
13) Constructing Division Problems		
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Lesson	score	
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Lesson	score	
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Lesson	score	
11) Concept of Division		
12) Interpreting Division Problems		
13) Constructing Division Problems		
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Lesson	score	
16) Solving Multiplication & Division Equations		
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18) Adding & Subtracting Time		
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Lesson	score	
21) Multiplication & Division Word Problems-Visual Models		
22) Multiplication & Division Word Problems-Equations		
23) Multiplication & Division Word Problems-Solutions		
24) Multiplying by Multiples of ten		
25) Additive & Multiplicative Patterns		

Lesson	score	
26) Unit Squares		
27) Concept of Area		
28) Area of Rectangles		
29) Recognizing Area as Additive		
30) Area of Basic Composite Figures		

Lesson	[illegible]	
31) Using Visual Models to Understand the Distributive Property		
32) Understanding Fractions-Equal Areas		
33) Understanding Fractions-Notation		
34) Unit Fractions on the Number Line		
35) Fractions on the Number Line		

Lesson	[illegible]	
31) Using Visual Models to Understand the Distributive Property		
32) Understanding Fractions-Equal Areas		
33) Understanding Fractions-Notation		
34) Unit Fractions on the Number Line		
35) Fractions on the Number Line		

Lesson	[illegible]	
31) Using Visual Models to Understand the Distributive Property		
32) Understanding Fractions-Equal Areas		
33) Understanding Fractions-Notation		
34) Unit Fractions on the Number Line		
35) Fractions on the Number Line		

Lesson	[illegible]	
31) Using Visual Models to Understand the Distributive Property		
2) Understanding Fractions-Equal Areas		
3) Understanding Fractions-Notation		
4) Unit Fractions on the Number Line		
5) Fractions on the Number Line		

Lesson	[illegible]	
1) Using Visual Models to Understand the Distributive Property		
2) Understanding Fractions-Equal Areas		
3) Understanding Fractions-Notation		
4) Unit Fractions on the Number Line		
5) Fractions on the Number Line		

Lesson	[illegible]	
36) Modeling Equivalent Fractions with Number Lines		
37) Visual Models of Equivalent Fractions		
38) Whole Numbers as Fractions		
39) Whole Numbers as Fractions on the Number Line		
40) Comparing Fractions with the Same Numerator or Denominator		

Lesson	[illegible]	
36) Modeling Equivalent Fractions with Number Lines		
37) Visual Models of Equivalent Fractions		
38) Whole Numbers as Fractions		
39) Whole Numbers as Fractions on the Number Line		
40) Comparing Fractions with the Same Numerator or Denominator		

Lesson	[illegible]	
36) Modeling Equivalent Fractions with Number Lines		
37) Visual Models of Equivalent Fractions		
38) Whole Numbers as Fractions		
39) Whole Numbers as Fractions on the Number Line		
40) Comparing Fractions with the Same Numerator or Denominator		

Lesson	[illegible]	
1) Modeling Equivalent Fractions with Number Lines		
2) Visual Models of Equivalent Fractions		
3) Whole Numbers as Fractions		
4) Whole Numbers as Fractions on the Number Line		
5) Comparing Fractions with the Same Numerator or Denominator		

Lesson	[illegible]	
1) Modeling Equivalent Fractions with Number Lines		
2) Visual Models of Equivalent Fractions		
3) Whole Numbers as Fractions		
4) Whole Numbers as Fractions on the Number Line		
5) Comparing Fractions with the Same Numerator or Denominator		

Lesson	score	
41) Recognizing Valid Fraction Comparisons 1		
42) Introduction to Data Displays		
43) Solving 2-Step Word Problems		
44) Modeling & Solving 2-Step Word Problems		
45) Classifying Quadrilaterals 2		

Lesson	score	
41) Recognizing Valid Fraction Comparisons 1		
42) Introduction to Data Displays		
43) Solving 2-Step Word Problems		
44) Modeling & Solving 2-Step Word Problems		
45) Classifying Quadrilaterals 2		

Lesson	score	
41) Recognizing Valid Fraction Comparisons 1		
42) Introduction to Data Displays		
43) Solving 2-Step Word Problems		
44) Modeling & Solving 2-Step Word Problems		
45) Classifying Quadrilaterals 2		

Lesson	score	
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Lesson	score	
41) Recognizing Valid Fraction Comparisons 1		
42) Introduction to Data Displays		
43) Solving 2-Step Word Problems		
44) Modeling & Solving 2-Step Word Problems		
45) Classifying Quadrilaterals 2		

Lesson	score	

Lesson	score	

Lesson	score	

Lesson	score	

Lesson	score	

Sample 3rd grade benchmark scoring sticker to monitor progress and see Quantile ranges for student data binder.

Beginning Benchmark
__________ _____%
Mid Year Benchmark
__________ _____%
End Year Benchmark
__________ _____%
Passed Lessons_______
(18 by break, 35+ year)

Quantile Scores
Far Below EM-130Q
Below Basic 135-235Q
Basic 240-385Q
Proficient 390-770Q
Advanced 775Q +
Grade 1 2 3 4

Beginning Benchmark
__________ _____%
Mid Year Benchmark
__________ _____%
End Year Benchmark
__________ _____%
Passed Lessons_______
(18 by break, 35+ year)

Quantile Scores
Far Below EM-130Q
Below Basic 135-235Q
Basic 240-385Q
Proficient 390-770Q
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Beginning Benchmark
__________ _____%
Mid Year Benchmark
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End Year Benchmark
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Passed Lessons_______
(18 by break, 35+ year)

Quantile Scores
Far Below EM-130Q
Below Basic 135-235Q
Basic 240-385Q
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Beginning Benchmark
__________ _____%
Mid Year Benchmark
__________ _____%
End Year Benchmark
__________ _____%
Passed Lessons_______
(18 by break, 35+ year)

Quantile Scores
Far Below EM-130Q
Below Basic 135-235Q
Basic 240-385Q
Proficient 390-770Q
Advanced 775Q +
Grade 1 2 3 4

Beginning Benchmark
__________ _____%
Mid Year Benchmark
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End Year Benchmark
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(18 by break, 35+ year)

Quantile Scores
Far Below EM-130Q
Below Basic 135-235Q
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Beginning Benchmark
__________ _____%
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Beginning Benchmark
__________ _____%
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End Year Benchmark
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Passed Lessons____
(18 by break, 35+ year)

Quantile Scores
Far Below EM-130Q
Below Basic 135-235Q
Basic 240-385Q
Proficient 390-770Q
Advanced 775Q +
Grade 1 2 3 4

Student weekly Reflex sticker for students to self monitor green lights, percent proficient, fact pathway, number of picture puzzles completed, and focus facts for the week.

Reflex Basics: Other information can be found in the teacher guide provided by the company.
You choose a username & password. Keep the username short. You will create a class and choose the button add students from the school roster. You can shorten the roster choices by choosing a grade level. You need to also choose an assignment path for the students. When this is done, students can login & play.

The student username/login is the same for the student as the teacher-this is why it would be beneficial to keep the username short. The student would then click their class and choose their name. Then they enter their individual password to login.

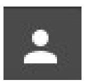
Shorter, more frequent sessions are recommended. It takes 10-15 minutes for a green light. 2-3 green lights per week are beneficial. If a green light is not manageable, have the student get through the picture puzzles.

The **classroom management tab** would list the student name, id, password and pathway. They can be assigned only one pathway-add/subt 0-10, mult/div 0-10, and mult/div 0-12 at any time. This would be assigned under the classroom management tab.

The **class report tab** has 4 parts.
1)The group status provides student name, assignment, if the initial assessment is complete, percentage of fact fluency, fluency gain in last week, green light & usage in last week, and date of last login.
2)The usage summary provides a table that provides assignment, total usage in days, weekly usage average, green light usage and total facts solved and a chart that shows weekly usage rate (green/good, yellow/close, orange/low, & red/little to none), and the average fact gain for each group per week.
3) The milestones shows both individual milestones for students and class milestones. Each of these can be printed as a certificate. The program keeps track of which have been printed.
4) The fluency growth shows several graphs including the following: a bar graph of student starting fluency to current fluency average as a class; a pi graphs showing starting fluency compared to current fluency in the wedges of still assessing, 0-49%, 50-79%, 80-94%, and 95-100%; a group histogram showing starting compared to current fluency with number of students compared to fluency in increments of 5%; and a line graph showing fluency gain or total fluent facts and usage.

The **individual report tab** has five sections. The overview shows total usage, fluency facts gains, average usage per week, progress on initial assessment, a bar chart with starting & current fluency, green light overall percent, and specifics over last 7 days for individuals. The fact detail provides a visual of fluency facts (dark green fluent, light green assessed, & white not assessed) in family pyramid report or separate addition & subtraction or multiplication & division charts. The milestones list the assignment, date reached, milestone, and if the milestone has been printed by individuals. The usage can show a chart or graph of usage by last 14 days, last 28 days, this school year, all-time usage or custom for each student. The fluency growth shows a chart or table with fluency gain, total fluent facts, date, and usage days on a chart or graph of usage by last 14 days, last 28 days, this school year, all-time usage or custom for each student.

To see what a student sees & try games, go to the upper right & click the person icon



Scroll down to Demo student account

Characters:

Crabby welcomes you to the games & introduces the site.
Dwight is the rabbit who reminds you to type numbers and a couple facts to check pace for the day. Pass (skip a question) by pressing space bar
Coach Penny is a bear who helps you practice facts. Coach Penny will often introduce a new fact family & have you type in the new focus facts for that family. Next, you finish the coaching session by completing 2 picture puzzles, and Coach Penny lets you know how many fast facts you got and your longest fast fact streaks. If you type the answer while the square is green, it is a fast fact. Yellow is approaching, and red is incorrect. Sometimes when it is incorrect, it will have you correct the fact if it is a focus fact or a fact you've already mastered.

GAMES
Students have to earn a certain number of green lights to get to open new games. Only one green light can be earned each day. A green light represents 250 correctly answered facts. As you progress through games, more complicated problems, paths, & dangers make the game more difficult. This makes it more important to know facts well, or the distractions become too much, and you lose the game & have to start over.

- Kirie: A maze game where students move along pathways to collect items by answering facts and avoid getting captured by person chasing them.
- Alien Sundae: A game where students fill orders by answering facts to choose the correct ingredients for an order.

- Slither: A game where students are adding to the slithering line that. Students choose a fact on the page & travel to the fact but must avoid an object traveling on a line.
- Ninja to the Stars is open and provides many facts to choose from to move up past the mountains and moon. There are stars to collect. This is a recommended game for a quick pace/faster green light.
- Swamp Chomper: a frog has a choice of about 4 lilypads with facts to jump on. There are flies and other extra features. This is a recommended game for a quick pace/faster green light.
- Egyptian Conniption: A game where a cat zaps cobras & other creatures in holes by answering facts. This is a recommended game for a quick pace/faster green light.
- Wind Rider-open and is slow-moving with 3-4 facts to choose from to move the balloon in the direction of fact chosen. The student tries to keep the balloon in the air by answering facts.
- Fizz Head: A game where different faces are dropped into water beaker. Student solves one of 3 facts to move right, left or down. The faces disappear when three of the same kind are stacked.
- Block Bot: A game on an area model floor where pieces are missing (holes), and their robot can go in one of 4 directions depending on the fact chosen.
- SQ World: A more recently added game (October 2019) where the squirrel collects acorns & toys on a small world before winter by answering facts.

When a student has answered enough facts correctly, they get a green light & can proceed to the store. They can spend their tokens on avatar items and tree house items.

There are many certificates that can be printed (number of facts, milestones, & mastery)

Getting email updates: This setting can be changed in the teacher user profile under manage profile. Teachers can share access to classroom data by giving access to another teacher, under class settings. Parents can be given invitations to have access to their students. Under classes, if you scroll to the bottom and you can click on print to have the option of printing parent invites.

Addition Fact Mastery Progress for ______________________

121													
120													
115													
110													
105													
100													
95													
90													
85													
80													
75													
70													
65													
60													
55													
50													
45													
40													
35													
30													
25													
20													
15													
10													
5													
0													
month		Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May		

Subtraction Fact Mastery Progress for ______________________

121													
120													
115													
110													
105													
100													
95													
90													
85													
80													
75													
70													
65													
60													
55													
50													
45													
40													
35													
30													
25													
20													
15													
10													
5													
0													
month		Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May		

Multiplication Fact Mastery Progress for ____________________

121													
120													
115													
110													
105													
100													
95													
90													
85													
80													
75													
70													
65													
60													
55													
50													
45													
40													
35													
30													
25													
20													
15													
10													
5													
0													
month		Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May		

Division Fact Mastery Progress for ____________________

121													
120													
115													
110													
105													
100													
95													
90													
85													
80													
75													
70													
65													
60													
55													
50													
45													
40													
35													
30													
25													
20													
15													
10													
5													
0													
month		Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May		

Appendix B: Permission to Conduct Research

I was told by a previous assistant superintendent there were no required district forms or applications to conduct research. An email on July 6, 2018 from the current Assistant Superintendent for Learning and Accountability to confirm this has been placed in this section.

Jennifer Guy 12:19 AM (11 hours ago)

to me

Congratulations!

You do not need to complete anything else to collect data. You may use student and school data as long as you do not disclose student names with the data.

If you would like to cite Amy students by name, you need to get a release from their parent. Let me know if you need a release.

Let me know if I can help in any way. If you need access to district, or school wide, data, I am happy to set that up for you. Erin Middleton, district data specialist, may be a good contact.

Jennifer

Sent from my iPhone

Appendix C: Email Invitation to Participate

Dear Co-workers,

I am the third-grade teacher employed at your school and have arrived at the doctoral research portion of my studies. I am sending you this letter because I am conducting a research study on the implementation of Reflex and TTM at our school to improve math performance. This study is part of my requirement for the EdD program at Walden University.The study will include all willing teachers who have experience with these programs. Upon accepting this request to volunteer in this study, you will be asked to participate in a one to one or focus study group interview depending on your choice. I would also request permission to do a short classroom observation when you are using the programs. Along with this interview I will be asking you to complete a brief anonymous survey. Attached you will find a copy of an informed consent form for your review. Please reply and return a signed copy of the consent form by (the date will be given). For this study, I hope to uncover how teachers view their abilities and experiences with using the Think Through Math/Imagine Math and Reflex programs. I hope you are willing to participate.

If you need further information about my study, please feel free to contact me by email at carolyn.torres@waldenu.edu, in person, or by telephone at 505-672-3038.Thank you for partnering with me in this study as I am excited to compile data from our staff's experiences with the TTM & Reflex programs.

Sincerely,

Carolyn Torres

Appendix D: Consent Form

A copy of the approved consent form from 11/28/2018 has been placed in this section.

Consent Form

Invitation to Participate:
You are invited to take part in a research study about the implementation of Reflex and Imagine Math (Previously named TTM, also known as Reasoning Minds for K-1) at our school to improve math performance. I am inviting the teachers who use or have used the Imagine Math and/or Reflex programs to participate. I obtained your name/contact info via the staff directory. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part or not.
This study is being conducted by a researcher and co-worker named Carolyn Torres, who is a doctoral student at Walden University. You likely know the researcher as a colleague who teaches third grade in your school.

Background Information:
The purpose of this study is to investigate implementation of Reflex and the Imagine Math programs at our school to improve student math achievement.

Procedures:
If you agree to be in this study, you will be asked to:

- Allow a classroom observation by researcher for 10-30 minutes depending on your set computer time. Time will be set at your convenience through email unless you have indicated a difference choice of contact.
- Participate in a one on one or focus group interview by me regarding your experiences in implementing the Imagine Math and/or Reflex. The interviews will take place after school hours in a classroom of your preference. The approximate length of each interview will be 30-60 minutes. Time will be set through email.
- Interview questions are open-ended and you will be free to share any information regarding this study that you feel is most important to you as a classroom teacher.
- Allow an audio recording of the interview to be transcribed by the researcher.
- A 5-10 minute review of the transcripts and my interpretations of your responses to confirm accuracy through email (about 1 week after the interview). I will follow-up to see if we need to discuss any concerns from your review.

Voluntary Nature of the Study: This study is voluntary and you should feel free to accept or refuse the invitation. No one at Walden University, the local district, or I will treat you differently if you decide not to be in the study. If you decide to be in the study now, you can still change your mind later. I will follow up with you to confirm your participation. You can withdraw at any time for any reason. You also can decline to answer or skip any interview/focus group question for any reason. There will be no negative impact on our relationship if you choose to skip questions or discontinue at any time.

Risks and Benefits of Being in the Study: Participation in this study should pose no risk to your safety or well-being, though it may cause minimal stress related to the process of being interviewed, recorded, and observed. There is also a chance of disruption and discomfort to your students by having me visit the classroom, though I will not interact with the students. This study seeks to better understand our teachers' experiences in implementing the Imagine Math and

Reflex programs. This study's main benefit will be to our school and district for those implementing or providing PD for the programs.

Payment: There will be no payments or gifts associated with participation in this study.

Privacy: Reports coming out of this study will not share the identities of individual participants. Details that might identify participant such as your grade level or location of the study will be kept confidential. I will not use your personal information for any purpose outside of this research project. A brief summary of the results will be provided to you upon completion by the researcher. Data will be kept secure by recording interview responses and providing all participants pseudonyms as well as for the school. The researcher will be the only person who will know the identities of those participating. Any information shared via this study will be shared in a way that protects the identity of participants. All data, including contact information and interview responses, will be stored in password protected computers. Data will be kept in a locked cabinet in my residence for at least 5 years, as required by the university. At the end of that five year period the data will be permanently destroyed. In the event of discovering any safety concerns regarding children, I am obligated to report concerns to the counselor and administration for follow-up as is the obligation of all educators.

Contacts and Questions: You may ask any questions you have at this time. If you have questions later, you may contact me in person, by phone at 505-672-3038 or email at carolyn.torres@waldenu.edu. If you wish to speak privately about your rights as a participant, you can call the Research Participant Advocate at my university at 612-312-1210 or send an email to irb@email.waldenu.edu. Walden University's approval number for this study is 11-28-18-0527720 and it expires on November 27, 2019.

Obtaining Your Consent: If you are willing to participate in the study and are ready to make a decision, please indicate your consent by signing below and returning the form. The form can be returned to me through email or my mailbox. Please keep copy of this form for yourself. If requested, the researcher can provide a copy of this form at the time of the interview.

I have read the information given in the invitation to participate document and also the consent form. My signature below indicates that I agree to the terms and conditions explained.

- I agree to have my interview recorded and transcribed.
- I agree to allow the researcher to observe my class for the purpose of collecting data related to implementation of the Reflex and Imagine Math programs.

Please sign and return with your signature by (date of 1 week from sending):
This form can be emailed back to carolyn.torres@waldenu.edu or returned to my mailbox in the teachers' lounge.

Printed Name of Participant: ________________________________
Participant's Signature: ____________________________________ Date: ________
Researcher's Signature: ____________________________________ Date: ________

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Appendix E: Researcher Confidentiality Form

Confidentiality Form

I __Carolyn Torres___, agree to maintain confidentiality of the survey/observation/interview/focus group by abstaining from revealing any individual's identity who is involved in any part of the discussion/data collection that that takes place. I understand that each individual has volunteered to participate and is entitled to their privacy.

Please sign and date below:

Signature: ___carolyn.torres@waldenu.edu_ Date: _11/28/2018__

Appendix F: Interview Questions

Time of interview:

Date:

Location:

Interviewee:

Years teaching: Pseudonym: Role: Teacher Admin Other

Say: This research is being conducted as part of my doctoral work at Walden University. This interview will provide me information regarding the implementation of TTM and Reflex and its effect on student achievement. No one from Walden University or our local district will treat you differently based on your responses. There is no compensation or reward associated with participation in this study. All information collected during this process will be reported confidentially, with pseudonyms used for both you and your school. You may choose to end the interview or back out of the research project at any time. Participation is voluntary. You will be given the opportunity to review my findings to make sure your views are adequately and truthfully represented before the completion of the study. This interview will consist of about 10 questions and should take no more than an hour.

The following are sample questions that will be used for the interview:

1) Based on your experience, what are your perceptions of the TTM/Reflex program? and of the professional development provided?Please expand.

2) How does the program align with your content, concepts, teaching practices, and technological skills? CK, PK, TK

3) With what frequency do you utilize the TTM/Reflex? Based on your training and usage, can you describe the implementation of the program? Could you give specific examples of areas of ease or difficulty?

4) Would you recommend expanding the program to the district? If so, do you have any suggestions for changing or improving the PD?

5) What resources in your school assist you in implementing TTM/Reflex? Suggestions.

6) How has your content matter changed (if it has) with the use of Reflex/TTM? TCK

7) What changes have you noticed in your teaching and your student's learning from using technology? TPK

8) Can you provide examples of your interactions with thesetting up, activating, and implementingthe TTM/Reflex program and support systems?

9) What are all the advantages and challenges of implementing the TTM/Reflex program?

10) How has the integration of TTM and Reflex influenced the content and pedagogy and student achievement? PCK, TPACK

11) Is there anything else you would like to add about TTM/Reflex that I did not ask?

Appendix G: Observation Journal

Classroom setting:	Pseudonym:

Observer:

Role of observer:

Time of observation:

Date:

Length of observation:

Descriptive data	sketch and descriptions of individuals, phys
ical setting, events, and activities particularly focused on the inclusion of technology	**Reflections** themes, quotes, and personal experience