Increasing Achievement in Mathematics: A Comprehensive Approach

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Review of the Literature

Introduction

Over the past ten years, the infusion of educational technology into the mathematics classroom has become essential. The types of technology and how educators are utilizing them have been a critical part of educational research. For years, mathematics educators have established a practice of implementing programs and resources in their classrooms that offer students the opportunities to engage in higher-order thinking, to understand thought-provoking questions, and to master problem solving. Due to the innovation in technological programs, mathematics can further enhance fluency in student learning, creativity, and encourage social interactions (Jung & Conderman, 2015). However, the use of technological programs in mathematics requires students to develop new literacies necessary for both consuming and producing interactive mathematical understanding (Wimmer, Siebert, Draper, Manderino, & Castek, 2017). Additionally, the research makes note of a variety of barriers to educational technology implementation in the mathematics classroom, despite availability and general acceptance of the presence of the technology by both teachers and students.

Availability vs. Implementation

Although there are numerous technologies available for use in the classroom, research finds that there is still a wide skill and integration gap that exists in education. Hampshire (2014) notes that 53% of teachers do not integrate technology into their classrooms, including in mathematics, despite the cultural push towards implementation and an understanding among those same teachers that technology indeed holds value in the classroom. Thus, the research is largely focused on assessing why that gap exists.

Difficulties by Pre-Service Teachers

Several studies have attempted to quantify the influence that technology is having on mathematics instruction. Hakim (2015) studied pre-service mathematics teachers to quantify their beliefs and perceptions regarding the use of technology as a teaching tool. The author conducted a mixed methods study of 105 pre-service secondary math teachers in New York and found that although there was a positive correlation between constructivist attitudes towards instruction and the use of technology in the classroom, interviews conducted with a sample of those participants revealed a lack of depth in that technology use and that there was general discomfort with effective pedagogical implementation. Hakim further notes an apparent overall disconnect between the quantitative survey results, which noted enthusiasm for technology use, and the realities of actual implementation, which suggested a need for pre-service training on effective instructional techniques using technology.

Other studies have also supported these observations. Agyei and Voogt (2010) distributed surveys to and conducted interviews with teachers in Ghana and found an overall lack of technology integration in mathematics classrooms. They noted that the boundaries to such implementation included a lack of pedagogical knowledge, largely caused by the absence of professional development and training opportunities prior to and early in their careers. Hardy (2008) notes that both preservice and current-service teachers have indicated that many of the training protocols that do exist are focused on teaching *about* technology, rather than teaching *with* technology. Further, the author notes that much of the technology training focuses on using technology to assist with clerical tasks, such as grading, word processing, and spreadsheets, rather than specific instructional applications that would enhance student learning outcomes.

Several studies have examined the pedagogical practices of early-service teachers. Orlando and Attard (2015) observed two sets of early-career mathematics teachers, one using interactive whiteboards (e.g. SMART boards) and the other using tablets. The researchers noted that although there were positive impacts on instruction, the technology-rich atmosphere provided challenges to a traditional teaching setting with which they were most familiar and were trained to engage in. Between the two, the interactive whiteboard setting provided the least conflict, as it represented a relatively even substitution from a traditional blackboard or whiteboard; however, the tablets, and their corresponding activities, necessitated a reconfiguration of the classroom environment, and challenged the traditional roles of the students and the teacher. The authors suggest that these challenges impacted early career teachers in particular because of a pedagogical conflict with the traditional paradigms of education in which they were trained.

Veteran Teachers and Technology

Another area of interest is in the technology competencies and pedagogies of what can be considered experienced, veteran teachers. Stoilescu (2011) studied three educators, each of which had over 15 years of experience in teaching mathematics, and noted expertise in educational technology in their classrooms, as judged by self-reported perceptions and experiences. The findings of the research revealed something of a gap between the perceptions of how those educators perceived *themselves* to be using technology, and the observed reality of that use. Though the participants reported in-depth and comprehensive technology implementation in the mathematics classroom, including student experimentation with knowledge, collaboration with peers, and teacher-to-student communication and evaluation, those same participants reported great difficulties maintaining existing technologies and

becoming proficient in the newest technologies as they are rolled out. In addition, there was a noted level of difficulty in guiding students to using technology in "significant" ways, which seemed to directly contradict their self-reported expertise.

Technology Implementation and Anxiety

The learning of mathematics is often associated with anxiety on the part of students; however, research also notes that the ever-expanding push for technology implementation is also causing additional anxiety on the part of educators. Tatar, Zengin, and Kagizmanli (2014) note that although pedagogical knowledge and the passing of that knowledge to students can in and of itself stimulate anxiety among educators, the pressures associated with integrating technology into that professional practice can negatively influence those already-existing anxiety levels. Additionally, it was found that with appropriate training and support at the district and school level, perception levels regarding the use of technology in mathematics classrooms increased, and anxiety levels in that same context decreased. As a result, compliance levels increased, and seemed to be correlated with increased professional satisfaction.

The Importance of a Learner-Centered Paradigm

A school or district's embraced paradigm related to the role of technology can also play a significant role in the outcomes related to that implementation. Specifically, as far back as the mid-nineties when educational technology was comparatively primitive to modern offerings, research has noted that technology must serve as more than a glorified delivery system for instruction (Stoilescu, 2011). Brown and Duguid (1993) recognized early on that the presence of educational technology in the classroom is no guarantee of success:

> The more educational technology is constrained to 'essentials' and 'individuals' the more
> it resembles a nugatory 'delivery system'...the more it risks becoming theft proof...A

preferable goal, it seems to us, is to design technology that provides an underconstrained

'window' into practice, allowing students to look through it onto as much actual practice

as it can reveal, to see to increasingly greater depths, and to collaborate in exploration.

The closer such technology can come to making theft possible, the better it is likely to be.

(p. 15)

Brown and Duguid (1993), in discussing the concept of *educational theft*, refer to the idea of

obtaining knowledge from the social periphery, in the spirit of Lave and Wenger's notion of a

collaborative and peripheral context to learning (1991). In short, it was established long before

the modern era that technology's mere presence isn't enough, nor can it simply hold the role of

substitution, as the SAMR model would define it (Hilton, 2016). Rather, for technology

integration in education, particularly mathematics education where there is an emphasis on skills

as well as knowledge, educational technology must be deep and related not simply to the

completion of problems and questions, but also the sharing and practice of knowledge in

meaningful ways. Otherwise, Brown and Duguid note that any technology implementation is

"futile." For example, the technology-based concept of flipped instruction is being embraced by

an increasing number of mathematics classrooms. De Araujo, Otten, and Birisci (2017) note the

prolific presence of online instructional videos from sources such as Khan Academy and

YouTube as the basis for the elementary and secondary expansion of the concept; that being said,

however, simply swapping the instructional and practice components of a mathematics

curriculum could be considered a simple delivery modification, and as such, the success of any

such initiative must include an assessment of how the technology-based practices will increase

student engagement and achievement. Specifically with regard to the flipped classroom, the

conversation should include mechanisms of maximizing student engagement strategies in the

face-to-face classroom, as well as assessment options during the home-based instructional period.

Barriers to Implementation

There have been projects that have sought to address the widely-noted deficit in technology education for teachers. Hardy (2008) conducted a study with nineteen middle and secondary mathematics teachers, both preservice and those in active service. The study, termed the Technology in Mathematics Education (TIME) Project, utilized a constructivist framework to provide an intensive course in the integration of technology, specifically videos, PowerPoint, Sketchpad, graphing calculators, and spreadsheet software, to actively enhance lessons. The researcher, also the instructor of the course being provided, provided an immersive environment in which participants actively engaged in the same types of activities that their students would engage in. The author concluded that intensive, experience-based courses in technology integration, particular those that engage participants in authentic activities that they can use in the classroom, were a necessity moving forward in technology implementation. Other studies concur with these recommendations, including a focus on ensuring that the content and skills being taught remain at the forefront, and that the technology is simply a tool to help achieve that end (Sturdivant, Dunham, & Jardine, 2009).

Other studies have attempted to delineate other reasons for technology compliance issues. Sturdivant, Dunham, and Jardine (2009) note three commonly-identified issues cited by practicing educators. These educators note a lack of skill or knowledge in terms of technology-rich pedagogies, the specific capabilities of a particular technology, as well as classroom management strategies in a technology-rich environment. In particular, the authors noted a common concern amongst teachers that there is a general lack of a skill base regarding the

differentiation that often accompanies the integration of technology. The authors also cite the "rule-based view" phenomenon which describes some of the most reluctant users of technology on philosophical grounds, including the belief that basic skill mastery must precede technology use or that technology is too often used as a crutch in courses such as mathematics. However, as a counterpoint, the authors cite a common alternative worldview of mathematics education as one that supports the wider skills of pattern recognition and problem solving. Teachers who hold mathematics in that regard tend to be more enthusiastic users of technology in the classroom.

Technology in Pre-Service Educational Training

Some researchers have attempted to trace deficiencies in educational technology implementation in mathematics classrooms to pre-service training programs. Asing-Cashman (2011) conducted a study of six professors of mathematics to assess the degree to which they modeled appropriate use of technology with their teacher candidates. Of the six professors studied, four modeled technology use in teaching mathematical concepts, while the other two went beyond that standard and demonstrated cases where students became "active learners" by having the ability to manipulate variables and to visualize different phenomena, which the author noted was evidence of "higher-order" technology implementation. In explaining the disparity, the research uncovered differences in what the participating professors deemed important skills for secondary mathematics students, while concurrently expressing a generally universal discomfort with the fast-paced implementation of new and emerging technologies, which can not only cause gradual pedagogical obscurity, but also issues with striking a balance between teaching with technology and the very real possibility that the training they are providing won't be preparing their teacher candidates with relevant technology education.

There have been noted issues in the research regarding the face-paced evolution of technology and its impact on training and eventual pedagogical expertise. Specifically, Stoilescu (2011) notes the relatively short lifecycle of many of today's technologies, which results in "new" technology, whether it be hardware or software, becoming obsolete in a couple years time, which is causing difficulties with educators who are making a good-faith effort to become masters. Further, because of the resources that are expended by schools and districts to acquire access to new technologies, there is great pressure on educators to maximize their use and to produce higher student learning outcomes.

Predicting and Supporting Technology Success in the Mathematics Classroom

One possible predictor of successful technology integration in mathematics classrooms is support. Hampshire (2014) conducted a study in grades 4-9 which examined the relationship between school-based technology support and pedagogical integration in fifty-seven teachers. Additionally, the research examined differences between novice and experienced teachers. The research concluded that there is a strong relationship between both district and school-based support and the likelihood that technology will be used in the mathematics classroom, and that collaboration amongst peers is an integral component to that support. Additionally, the research suggests that teacher experience in the classroom is a significant predictor of success in successful technology integration in the mathematics classroom. Research by Sturdivant, Dunham, and Jardine (2009) further suggests that faculty development in these areas must go beyond one-off seminars or programs for novice teachers only; rather, workshops in effective pedagogical techniques in technology implementation in the mathematics classroom must be ongoing and inclusive of all stakeholders.

Digital Mathematics Literacies & Technological Skills

Although today's students possess a broad range of digital literacy skills, they are not as fluent in mathematical literacies and must be taught how to interact with multiple modes of text and images. Many mathematical digital programs require students to manipulate geometric objects by double-clicking on points in order to click, move, rotate, resize, drag and drop them. Students can use their fluency with a computer mouse to briefly learn how to construct simple objects such as points, lines, segments, circles, angles, and polygons. Despite the ability to create these simple objects, many students are not as fluent in manipulating and addressing the properties of these objects as part of their formation (Wimmer, Siebert, Draper, Manderino, & Castek, 2017).

In addition, students must be fluent in technological skills in order to take the modern, online PARCC assessments. The PARCC assessment system is an annual year-end test in both English language arts/literacy and mathematics in grades 3-8 and high school. In the mathematics section, students solve multistep problems that require mathematical reasoning and show their understanding of each problem. They must also create equations based on real-world problems and posses a strong understanding of mathematical reasoning and applying concepts (Pearson Education, 2015). PARCC testing and benchmarks from the New Jersey Student Learning Standards have bestowed educators the necessity of creating purposefully planned lessons that include both mathematics and technology fluency (Jung & Conderman, 2015). Educators must thoroughly learn how to select specific target skills for their students and carefully monitor their progress. Educational technology programs can incorporate evidence-based intervention components (Hawkins, Collins, Hernan, & Flowers, 2017). However, before

selecting these types of programs, educators should carefully consider how they would be incorporated to supplement classroom instruction.

Selecting Target Skills And Students

Advances in technology are ever changing and the number of mathematical educational programs that help support students' mathematical skill development is ever increasing. Before selecting educational technology programs to supplement mathematics, educators should determine which mathematics skills will be targeted and if the program(s) will be used to supplement all students or specified intervention (Hawkins, Collins, Hernan, & Flowers, 2017). Educators should carefully consider what mathematics grade-level standards the program(s) address (i.e. New Jersey Student Learning Standards), whether or not they support the current curricular materials, and current performance levels of students. The program(s) should also collect student data from exercises and assessments, where educators can then compare individual students' performance to the benchmarks from learning standards. This data should help determine the support students need in order to achieve both mathematics and technology fluency (Burns, VanDerHeyden, & Jiban, 2006). An educator's role is essential in the decision of selecting, using, and evaluating the effectiveness of educational technology programs for educational purposes (Cheung & Slavin, 2013).

Feedback, Pacing, Engagement

Educational mathematical programs should provide students with correct answers to those responses that are incorrect. Positive indicators, such as green check marks or a thumbs up icon, should serve as reinforcement for correct responses. This type of feedback can inform students about their incorrect responses and guide them in the right direction. Research also indicates that the pacing of educational technology is linked to success. Mathematics programs

need to be swift in order to engage students and provide a concentrated amount of learning

assessments, but gradual enough in order to prevent frustration. Pacing, how slowly or quickly

mathematical facts are presented to students, is a key factor in regards to choosing educational

technology programs (Forbinger & Fuchs, 2014).

The level of student engagement correlated with the mathematics program should

alternate between practicing mathematical skills and stimulating games that are devised to grasp

and sustain students' attention. There are numerous programs and websites that offer an

assortment of games that allow students to select what interests them from an approved

collection of activities. By allowing the students the ability to change the types of games that

they are engaging with, different mathematics skills are introduced and repetition/boredom are

decreased. Engagement and motivation can considerably affect mathematics success, and

mathematics programs that include motivational elements such as goal setting and reinforcement

can affect students' learning percentages (Hawkins, Collins, Hernan, & Flowers, 2017). By

educators monitoring their students' performance, specific mathematical skills can be targeted

and achieved.

Progress Monitoring

Educational mathematics programs that contain built-in assessments may contravene the

need for educators to gather other assessment data as often as they might when using a program

that does not include an assessment section. Many mathematics programs include a student

performance summary report that includes progress using data that both teachers and parents can

access online. The data includes the types of problems that were presented to the students. Many

programs include the learning standards, as well, and adjust the types of problems that are given

to the students based on their assessment performance. This type of adjustment results in

improved design between student instructional level and activities (Polly, 2014).

Once mathematics programs are implemented, a plan that includes ongoing monitoring of students' mathematical facts fluency should be considered. Progress monitoring for all students, especially at-risk students, should be examined on a weekly basis. Monitoring allows educators to swiftly create modifications to both instruction and intervention in response to their students' progress (Shapiro, 2011). For example, Edmentum, a leading provider of e-learning solutions, is an adaptive, competency-based assessment program that assigns high-quality content and progress monitoring tools to target student instruction. The program automatically identifies the mathematical strengths and weaknesses of each student through progress monitoring and data. It then takes the data and offers targeted instruction aligned with goals, paced to students' needs, and designed to give students control over their own educational journey. The exclusive blend of assessment and instruction allows educators to constantly track academic growth and performance over time to modify instruction ("Edmentum", 2016). Modified instruction allows students to develop fluency in basic math facts, which then leads to fluency in the context of other types of math, essentially supporting inclusive mathematics achievement.

Online Playgrounds: Socialization And Collaboration

The use of educational technology is not a desolate tradition. Web 2.0's augmented interactive UI allows students to interchange online content in various forms. Collaborative learning instantaneously changes typical students into their peers' more knowledgeable others. Collaboration results in higher cognitive processes, which are crucial in early childhood mathematics (Cicconi, 2014). Online playgrounds that incorporate interactive tools and video conferencing allow students the opportunities to reflect on important mathematical ideas. Interactive online tools such as PBS Learning Media's "Logical Leaps: Rational Numbers on the

Number Line" allows students to calculate wallabies' jumping distance on a number line in the

form of fractions, mixed numbers, or decimals. Students can then determine how to display the

tick marks and position the wallabies on their designed spot on the number line (Johnson,

Hornbein, & Bryson, 2016). This type of interactivity corresponds to New Jersey Student

Learning Standards by allowing students to interpret statements of order for rational numbers in

real-world contexts.

Video conferencing allows both collaboration and communication and provides

opportunities for both educators and teachers to interact beyond the walls of their mathematics

classrooms. Tools such as Zoom's Shared Whiteboard and Screen Sharing features enables

teachers to digitally interact with their students, such as collaborating on homework assignments.

Students can take screenshots of their work while they are interacting with their teachers online

(Jones, 2016). This type of active learning and student participation can help foster students'

interaction with peers as well as their teachers. These types of online playground equipment can

deepen students' mathematical knowledge while engaging in new forms of interaction.

Implementation Planning

School districts should devise implementation plans that improve students' educational

outcomes in mathematics fluency. Educators must first consider the types of devices that will be

used in classrooms (i.e. Chromebooks versus tablets). Many apps available on tablets may not be

available on Chromebooks or may not be as user-friendly or run as smoothly on tablets.

Educators must also consider the amount of devices they have available for student use.

Monetary value and timing are also essential factors in implementing mathematical technology

(Hawkins, Collins, Hernan, & Flowers, 2017). There are many free web-based programs and

mobile apps, but they may be limited in their provided content and options as compared to

premium options.

School districts can research the different types of mathematical programs that meet their

state standards criteria for effective mathematics instruction. Program features, free online trials,

contacting publishers, and trying out programs at educational conferences should all be

considered. Content and instructional design should heavily be determined when evaluating a

mathematics program. The content's strength, including mathematical key concepts that promote

in-depth learning, multiple activities at various grade levels, open-ended activities / free

exploration, and real-world examples should be included in most mathematics programs.

Instructional design should be analyzed and provide easy navigation, understandable

symbols/icons for specific actions, provide effective feedback indicating incorrect responses and

allow students to try again, and an integrated saving capability so students can return to their

work and restart where they left off (Ginsburg, Jamalian, & Creighan, 2013).

If a school district has a vast amount of students, costs can become abundant. Therefore,

educators must balance the cost of these programs with the needs and preferences of their

students. Incorporating the programs(s) into their busy daily schedule of instructional time is also

a factor. Cheung & Slavin (2013) state that educational programs that are implemented for more

than 30 minutes per week are proven to be more efficient than those that are implemented less

than 30 minutes per week. However, allotting applicable time for educational programs continue

to be a challenge for educators.

Conclusion

As technology continues to develop, the field of mathematics will advance in its digital

literacies requirements. Innovations in technology have provided numerous digital tools for

learning and participating in mathematics. These interactive tools and their associated literacies

offer new methods for educators and students to think about mathematics, including engaging in problem solving and communicating about their mathematical rational. They also pose innovative challenges for mathematics teachers in supporting fluency in both mathematics and technology digital literacies (Wimmer, Siebert, Draper, Manderino, & Castek, 2017).

For the potential of the numerous educational technologies to be fully realized in the mathematics classroom, a number of external factors also need to be addressed, particularly in regards to training of both pre- and current-service educators, as well as the implementation of continuous professional development initiatives for educators. Numerous research studies have identified the lack of pedagogical training and support as major barriers to using technology efficiently in the mathematics classroom, and in ways that not simply substitute or augment delivery of instruction, but also creating new ways for internalizing and making meaning for students.

In order to enable modern mathematics learning that correlates to state standards, educators need to be thorough in evaluating and selecting mathematics programs, incorporating them with other classroom activities, and using additional types of educational technology to encourage collaboration and social interaction (Jung & Conderman, 2015). Educational technology concurrently guides the responsibilities of creating, evaluating, analyzing, and applying through collaboration into the classroom while producing greater passion for learning mathematics (Cicconi, 2014).

Recommendations

In 2006, President George W. Bush issued an Executive Order which convened the National Mathematics Advisory Panel, a blue-ribbon panel of experts in mathematics education. The panel was charged with reviewing the "best available scientific evidence" about teaching

mathematics, to attempt to close the gap between the United States and the many countries which are more effective in teaching mathematics (National Mathematics Advisory Panel, 2008, p. 9). The Panel reviewed every aspect of mathematics education, and published many significant findings, including that "recommendations that instruction should be entirely 'student-centered' or 'teacher-directed' are not supported by research" (National Mathematics Advisory Panel, 2008, p. 45). They also noted that "research on instructional software has generally shown positive effects on students' achievement in mathematics as compared with instruction that does not incorporate such technology" (National Mathematics Advisory Panel, 2008, p. xxiii).

Recommendations for the Classroom

With these findings in mind, the analysis for selecting software for our district's mathematics curriculum focused on competency-based software used as a supplement to teacher-led instruction. Competency-based instruction allows students to progress through lessons at their own pace, and presents material repeatedly until the student demonstrates mastery by applying the learning to real-world problems. It assigns students to curriculum based on mastery of the material, not on their grade-level (Steele, et al., 2014). The concept has its roots in Dewey's Experiential Learning Theory, as well as Bloom's work in Mastery Learning (Steele, et al., 2014, p 7).

In order to meet the objective of raising mathematics achievement scores, we recommend adopting DreamBox Learning, a software product that provides students with a themed environment which presents them with various interactive activities to learn and reinforce mathematical concepts. This product has several advantages. First, the program can be run on any web browser or on a free iPad app. Students have a single sign-on, and their progress is visible on any device (DreamBox Learning, 2017). This makes it possible to implement the

program with little hardware expense. Students can use the existing computer lab and other

devices for DreamBox lessons, and can also access the program from home at no additional cost.

DreamBox is aligned to the New Jersey Student Learning Standards and is compatible

with many mathematics textbooks. Teachers have access to extensive analytics and progress

monitoring, which can assist them in forming groups for small group instruction, and identifying

students who are struggling. Parents also have their own portal access into the program and can

participate in the process and encourage their child (DreamBox Learning, 2017).

Another advantage of the DreamBox program is that it is available in English and

Spanish, and students can toggle between the languages at will (DreamBox Learning, 2017). Our

district has a significant population of English Language Learners (ELL), the majority of whom

are native Spanish speakers. The multilingual feature will allow students who may not be as

comfortable in English to continue to develop their mathematical skills. Rubinstein-Avila, Sox,

Kaplan & McGraw (2014) conducted a case study of bilingual middle school students learning

mathematics in Arizona. They recommended that teachers strive to use a student's first language

to clarify concepts and encourage collaboration in problem-solving. They noted that these skills

were necessary to move on to higher level mathematics courses, which were required for college

admission (Rubinstein-Avila, Sox, Kaplan, & McGraw, 2014).

The adaptive nature of DreamBox makes it an appropriate choice of platform for diverse

students and special education students in an inclusion setting. Each student can progress through

the programming at his or her own pace, and teachers can provide personalized interventions that

these students may require as needed (DreamBox Learning, 2017).

Because it is web-based, there is no on-site installation of software needed for this

program. Once the purchase of the service is complete, faculty training can commence.

DreamBox support staff provide training onsite or online. The program also suggests training sessions in a dynamic fashion, reacting to student performance. These sessions can suggest new teaching strategies or provide deeper exposure to mathematical concepts. As teachers progress through the standard training levels, they eventually earn certification allowing them to turnkey to other teachers in the district (DreamBox Learning, 2017).

As noted above, we do not anticipate any hardware or technical support expense for the installation. We estimate that initial training to use the program should be completed in two to three training days, and then subsequent online training can be completed on-demand. DreamBox Learning support staff will be onsite for two days in August during our teacher workdays. We estimate the cost of this onsite training at $15,000 to cover personnel and travel expenses. The third day of training, if needed, can be scheduled via web conferencing during the September teacher workday. The annual cost of the DreamBox program is $20 per student, or $7,000 for unlimited licenses in a single school (EdSurge, 2017).

Recommendations for Home Instruction

Home instruction is available for either health-related or behavioral issues seen in students. In addition to DreamBox, these students can expand their mathematical skills using various online apps. Willacy & Calder (2017) studied the use of mobile learning, also known as m-learning, with special education students receiving home instruction who were underachieving in mathematics. Their research reviewed students who were either on home instruction or out of the classroom ten or more days and examined the impact of mobile apps on student engagement. The research revealed that using the apps improved math performance.

Acknowledging that both the Individual with Disabilities Act Section 300.105 requires assistive technology devices be included in a student's IEP (IDEA, 2004) and that not all

students learn and retain information in the same way, these enrichment applications offer

opportunities for support for success in mathematics fluency and achievement. Research on

Common Core Standards (Clemens, Fuson, & Samara, 2017, p.180) indicates a strong

foundation for math success begins at the preschool level. Recommendations are made for

programs from preschool thru elementary. The following are apps we suggest to assist these

learners:

- Montessori Numbers is designed for children from the ages of 3-7 using visuals to help

  children learn and will be used for home instruction only.

- Quick-Math helps children learn mathematics tables while focusing on improvement over

  time. This app will help special education students with their mathematical skills and

  ability to retain information. This app is designed for students from the ages of 6-12.

  (Shiny Things, 2014)

- There are several math games available on iSmartBoard.com:

  Whack-A-Mole - Helps teach students counting skills

  Sailboat Subtraction - helps students practice subtraction

  Tugboat Addition - helps students practice addition

Establishing mathematical fluency for these special needs students will lay the foundation

for higher learning (Hawkins, Collins, Herman & Flowers, 2016, p.141). Hawkins, Collins,

Hernan, & Flowers (2016) recommend monitoring at risk students weekly and make

adjustments and interventions to their programs as needed.

Implementation and Evaluation

In order to implement this initiative, we recommend a staged pilot program. The initial

rollout could be to the students enrolled in our Summer Enrichment program. The initial training

for the summer staff can be completed via web conferencing with DreamBox support staff

leading the session. Starting the program in the summer will allow teachers to become more

familiar with the features of the web-based program, and will allow a small number of students

to be experts in DreamBox before the formal roll-out to the school in the fall. It is also

recommended that we begin with a pilot deployment with one or two grades during the first year,

and add additional grades in years two and three. This will provide for experienced teachers to be

onsite to support new teachers as they adopt the program.

In order to assess the effectiveness of the initiative, standardized mathematics scores will

be compared before and after the adoption of the software. A successful adoption would be noted

if there is a 10% improvement in test scores after three years. For the younger grades which do

not participate in the PARCC standardized assessment, pre-tests and post-tests will be

administered to document the success of the initiative. A team of stakeholders, including district

and school administrators, technology committee, teachers, parents and technology specialists

will be charged with evaluating the program annually, reporting the results of this evaluation to

the Superintendent, and making recommendations for the future of the program.

Conclusion

Research has demonstrated that using technology in teaching mathematics helps students

develop the fluency they need both to excel at standardized tests, develop 21st century skills, and

prepare students for college. Our recommendation to incorporate the DreamBox Learning

platform as a supplement to teacher-led instruction will allow students to master mathematical

concepts at their own pace. Students will be able to participate in engaging activities which

contain extensive scaffolding as they achieve mastery. Teachers will gain valuable insights into

the challenges their students are encountering and will be able to target their efforts exactly

where students need help. Parents will have the option of becoming active participants in their

children's learning by viewing their performance in the Parent Portal.

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