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Abstract

This study examined the impact of iPad integration on student motivation, engagement, and learning skills in a mathematics program. Subjects included 143 students aged 8 to 14 years old and 63 parents in an Indian-based school in Dubai where the national curriculum required the use of tablets be integrated into school subjects starting at grade three. All subjects responded to questions about how iPads could support learning math and the kind of challenges students faced. Classes were technology-driven using individualized learning groups and a variety of computer apps. Around 80 percent of the students indicated they understood new concepts better, were able to solve difficult math problems, and expected themselves to score better on their tests. It was found that providing instant access to a wide array of applications, resources, hands-on activities, and instant feedback can engage students and help them remain on task, especially those with special educational needs.

Introduction

Benefits of mobile learning in an educational environment include increased motivation, collaboration, communication, and creativity. Mobile learning through tablet devices provides a viable tool for differentiated learning and instant feedback, freeing the teacher to facilitate higher order thinking skills. Singer (2015) argues that tablets are unique in that they are portable and offer applications (apps) that can be downloaded directly onto the device.

Kwak (2017) stated that past research on iPads in education focused on four main areas: student behavior, student attitudes, impact on learning, and characteristics of specific apps. Results were mixed and differed based on the app under investigation. For example, Singer (2015) claimed that there was no impact on motivation when using tablets, but Kwak noted that students were motivated when using tablets but the motivation level depended on the pp being used. Other studies also found that tablet devices increase motivation (Zimmerman & Howard, 2013; Riconsenta, 2013). The Kwak finding could explain why the Riconsenta (2013) study, which used a Math app specifically, found that motivation increased when integrating an iPad fraction game in a math lesson.

Tablets also provide a tool for collaboration, communication, creativity, and critical thinking. Keengwe (2013) noted that grade 3 students helped each other solve problems when using iPads in mathematics class. The students used their iPads to share screens with one another and with the teacher, to draw, and to collaborate on written responses in various locations. Dhir, Gahwaji, and Nyman (2013) stated that tablet devices supported communication through email and other communication applications. Matthews and Seow (2007) researched the drawing abilities of children from two years old to eleven years old. They found that tablet devices, with the use of a stylus pen, outperformed traditional media when used as a drawing tool. A study by Milman, Carlson-Bancroft, and Boogart (2014) revealed that tablet devices benefited students' critical thinking skills using a chalkboard app that was used to outline thought processes.

Literature Review

Constructivist Learning Theory (CLT) and Technological Pedagogical Content Knowledge (TPACK) helped researchers examine the effect of tablet devices on student achievement and attitudes in mathematics. The two theories also provided conceptual underpinnings from the literature related to this study's research questions.

Constructivist Learning Theory

The constructivist learning theory (CLT) suggests that each learner constructs, creates, invents, and develops distinct meaning and experiences as they learn (Liu & Chen, 2010). CLT has also steered the methods which teachers use for instruction. Teachers have roles as facilitators who provide information and arrange activities for students to enable them to construct their own learning.

According to constructivist theorists (John Dewey, Lev Vygotksy, and Jean Piaget) constructing learners' knowledge happens when students are provided with real-world situations as part of the learning process (Liu & Chen, 2010). Learners' cognition is developed as they interact with their environment and through their personal experiences (Dewey, 1897). CLT is at the core of this study on how the integration of the iPad into the learner's environment has transformed teaching and learning. While the teachers' role remained that of facilitator, the opportunities that they provided to students through the iPad were transformed to create new experiences for students as active learners (Liu & Chen, 2010).

Technological Pedagogical Content Knowledge (TPACK) Framework

TPACK, developed by Mishra and Koehler (2009), is a framework centered around the associations among content, pedagogy, and technology (Mishra & Koehler, 2009). In the TPACK model, the technology factor motivates the judgments regarding content and pedagogy. In preparing students for the 21st century, teachers need to be equipped with an awareness of the association between pedagogy and content knowledge with technological knowledge (Jang, 2010). Jang and Tsai (2012) found that the development of TPACK can help to maximize teaching effectiveness and efficiency and help teachers achieve more positive and preferable teaching

and learning outcomes. Koyuncuoğlu (2021) found that when graduate students in Turkey showed competencies in all areas of TPACK, their understanding of how to deliver content increased.

Following the TPACK model helped researchers understand the benefits of technology integration into the 21st century classroom and its association with an efficient teaching and learning environment (Koehler & Mishra, 2009). Teachers began to deal with the challenges that adding new technology devices such as iPads might cause for their teaching methodologies (Jang & Tsai, 2012). In a study conducted by Hill and Uribe-Florez (2020), the research showed that teachers who were confident in math education content and pedagogy tended to understand how to incorporate technology into lessons even though they expressed uncertainty when using technology in general. The TPACK framework was an essential component in structuring the qualitative component of this study and provided guidance for analyzing lesson plan documents to understand how iPad devices were implemented in the classroom.

Using iPads for Teaching and Learning Mathematics

Integrating iPads into the classroom has had a significant impact on teaching and learning. Instruction in traditional classrooms has been shifted to a place where students are active learners and in control of their learning (Falloon, 2013). The iPad transforms students' learning experience by providing instant access to important educational resources anywhere and anytime. iPads also serve as interactive and engaging devices that will develop students' skills and enhance their knowledge in all subject areas (Falloon, 2013). Using iPads as a means of instruction helps students remain on task, especially those usually hard to engage for long periods of time, including students with special needs (Conn, 2012).

For mathematics education, Milman, Carlson-Bancroft, and Boogart (2014) found that students use iPads in math to create books, access websites, demonstrate mathematical concepts through drawing and art, and for drill and practice. Integrating the iPad into math lessons impacts student attitudes towards math, positively affects learning, and allows the teacher to give instant feedback and differentiate instruction to meet student academic needs (Kwak, 2017). For instance, tablet-based games in math stimulated primary students' learning and increased their engagement in math activities (Kyanka-Maggart, 2013; Milman, Carlson-Bancroft, & Boogart, 2014).

The games also encourage learners to aim for higher levels of learning (Kyanka-Maggart, 2013). Through the use of iPads in math lessons, students are able to create books, access websites, demonstrate math concepts through drawing and art, and use them for drill and practice (Milman, Carlson-Bancroft, & Boogart, 2014). It was found that iPad applications improved students' performance in math better than when using the traditional method of teaching by providing students with the opportunity for both independent work and group activities (Maloney & Beilock, 2012). iPad integration supports at-risk students' learning because it individualizes to meet their needs and focuses their attention (Bennett, 2011). When comparing the effects of a worksheet condition and an iPad condition on academic engagement in a high school setting, it was demonstrated that more

academic work was completed correctly in less time and with higher levels of active engagement in the iPad condition as compared to the worksheet condition (Haydon, et al., 2012).

Research suggests that when teaching math to primary students using iPad, a student-centered learning environment is created, enabling students to control their own learning (Kwak, 2017). The tablet devices provide students with a more interactive and collaborative learning experience where students are engaged and focused (Conn, 2012). The results of the attitudinal survey used in the same study conveyed that students showed a significantly greater positive attitude towards their course compared to other students who did not use the devices. Students who have more positive attitudes towards math had better academic performance (Sanchez, Zimmerman, & Ye, 2004). Not only student attitudes towards math improved, but their mathematics confidence levels and knowledge as well. Riconscente (2013) found out that when using tablet game-based iPad apps in math, grade 4 students' confidence and knowledge increased and their average test scores on fractions improved over 15%. This improvement was a consequence of the instant feedback and scaffolding provided by the game and the amount of fractions practice that the game provided to the student.

A wealth of studies indicates a positive association between iPad use in mathematics on students' motivation, problem solving, and critical thinking skills (Haydon, Hawkins, Denune, Kimener, & McCoy, 2012; Riconscente, 2013). Furthermore, studies such as Matthews and Seow (2007) and Milman, Carlson-Bancroft, and Boogart (2014) showed that students express their thought processes better when using tablet computers than using traditional classroom tools such as pencil, markers, paint, and paper in natural settings. When videotaping 12 children between ages two to 11 years old drawing with both tablet computers and traditional classroom tools, participants expressed their thoughts through drawings better with electronic tablet computers (stylus-interfaced technology) as compared to the traditional media tools.

Using tablets in class increases communication among students and teachers and enriches student collaboration and communication specifically at the primary level (Keengwe, 2013). The use of iPads improves ways learners and teachers in the classroom are able to communicate and collaborate with each other. For instance, students are able to communicate visually by capturing images and sharing knowledge in a peer-to-peer world (Berk, 2010). Additionally, using iPads, iPod Touch, and Google Earth facilitate collaboration and communication among students because they are offered the opportunity to share screens, manipulate drawings, and trade written responses with their peers in groups or when completing other class projects. These technological devices have built-in tools that promote relationships among all learners that include emailing and communication applications.

Despite these benefits, several issues were reported when using iPads for teaching math such as distractibility, issues with monitoring progress, and limited indications of actual learning (Kwak, 2017). Conn (2012) argued that it is fundamental for teachers to introduce the device by modeling proper behaviors related to the care and maintenance of the iPad. Including parents into this process can also help to create a feeling of ownership for the students that will encourage them to take care of the devices (Holcomb, 2009). McClain and North (2021) also recommend that in order for math teachers to use educational tools correctly, there needs to be clear and direct

professional development based on ongoing needs as expressed by educators. Harrison and Lee (2017) also found that it was important for teachers to know how to use an iPad App effectively. Often educators focus on choosing the App which is only the first step. Equally as important, is being able to incorporate the tool successfully.

Parents Views on iPads in the Classroom

Khoo, Merry, Nguyen, Bennett, and MacMillian (2015) found that while parents saw the iPad as one form of a learning tool for children, they did not want iPad use prohibited in the schools or at home. Parents believed their children needed to have a certain amount of iPad literacy as part of their education package and that schools and homes should develop rules and guidelines to guide students when using the iPad. Another study suggested that while iPads and similar devices increase communication between parents and educators, there needs to be some training on how to communicate in order to ensure the safety and confidentiality of the students and families (Beschorner & Hutchison, 2013). To date, these are the overarching themes available in the current literature. More studies which focus on parental perspectives of learning using iPads and tablet devices need to be conducted.

Research Questions

Students and parents were surveyed to determine how well the iPad as a support tool was received. The research questions explored were as follows:

RQ1: In which ways did the iPad support mathematical learning?

RQ2: What challenges did the students experience when using the iPad as a tool for learning mathematics?

Milman, Carlson-Bancroft, and Boogart (2014) state that very few studies have focused on using tablet devices as a tool to teach and learn mathematical concepts, even though there is a need for students to develop the 21st Century skills of collaboration, communication, creativity, and problem solving (Bray & Tangney, 2016).

Methodology

Context

The study was conducted in an Indian K-12 private school in Dubai. The school follows the Central Board of Secondary Education (CBSE) Indian curriculum. CBSE is a national-level board of education in India for all public and private schools, and is regulated and operated by the Union Government of India. As part of its iPad integration initiative, the school has incorporated iPads as a teaching and learning tool. All students in the school, Grade 3 and above, are issued their own iPads by the school. The school teaches English, Arabic, French, Malayalam, and Tamil. The language of instruction is English in all subjects with the exception of Arabic and Islamic courses. All classes are technology-driven, and the students learn using a variety of apps and mobile learning tools. The school prides itself on the small class sizes, which allow for individualized and enjoyable learning experiences for all pupils.

The current study focuses on students and their experience with the iPad initiative particularly in Math classes. As all students have their own devices, the content materials are all digital. Students study two periods of math from Sunday until Thursday (the weekend in the UAE is on Friday and Saturday). The school provides a fast and efficient WIFI connection to all students and teachers alike so they can access their devices throughout the school day. Moreover, the school's IT department offers technical support to both students and teachers when needed. Students and teachers in the current study did not undergo any formalized training in using the iPad as a teaching and learning tool before the iPad integration, but have learned through various one-off workshops offered by external experts.

Subjects

The participants in the present study consisted of 143 students: 23 in grades 6-8 and 120 in grades 3-5. Their ages ranged between 8 and 14 years old. The students were all in their same respective classes for the full semester term of the academic year. The study was conducted in the second semester term. All students were Indian nationals enrolled in the school with differences in their mother tongue, but all spoke English as a second language. The length of their exposure to English instruction ranged from 3 to 8 years, depending on their grade level.

The sample consisted of 52 females and 68 males in grades 3-5 and 6 females and 17 males in grades 6-8. All participants had their own iPads with the necessary apps for their course of study in math and for the purpose of this study. 63 parents completed the survey. All of the parents were Indian nationals who lived in Dubai and sent their children to the private school for Indian nationals.

Data Collection

Based on the literature review, a survey was developed by the researchers and sent electronically through Googleforms to the participants. Validity of the survey was tested through piloting and reliability was established through repetitive testing. The purpose of the pilot test was to determine if the questions made sense and not to collect data. The results achieved reliability through multiple stages of developing, checking, and cross-checking categories, themes and responses (see the Appendix for a sample of the questions asked).

Participants' parents were asked to sign consent forms by the school prior to the deployment of the surveys. In addition, the participants agreed to take part in the study by accepting an online statement. Data from the participants were all anonymous and didn't include any identifying information which could be linked to the respondents. All responses were stored in the online survey platform Survey Monkey and were password protected. The survey asked participants to provide feedback on their opinions on the use of iPads in learning math.

In addition, in grades 6-8, at the end of each part, an open-ended section was added to give the students a chance to explain and expand their responses regarding the use of iPads in learning math. These answers were used to

gather the qualitative data for the project. The school sent parents the survey while the researchers could see the responses in real time.

Findings

Responses were averaged using 1 for "Strongly Disagree," 2 for "Disagree," 3 was "Neither agree nor disagree," 4 for "Agree," and 5 for "Strongly Agree." Averages of 3.5 or higher were considered to be an agreement by the participants.

Profile of Math Interest

Before answering the research questions, a profile of the students' interest in math needed to be established (see Table 1).

Table 1. Profile of Math Interest Averages

Statement	Participants (*n*)	Response Average (*M*)*
I like math.	Grades 3-5 (*n*=120)	*M*=4.48
	Grades 5-8 (*n*=20)	*M*=3.78
	Grades 3-8 (*n*=143)	*M*=4.37
		1 (*n*=6)
		2 (*n*=4)
		3 (*n*=7)
		4 (*n*=40)
		5 (*n*=86)
Math is a very important subject.	Grades 3-8 (*n*=120)	*M* = 4.68
		1 (*n*=3)
		2 (*n*=1)
		3 (*n*=2)
		4 (*n*=19)
		5 (*n*=95)
I want my math skills to grow.	Grades 3-5 (*n*=120)	*M* = 4.8
		1 (*n*=2)
		2 (*n*=0)
		3 (*n*=2)
		4 (*n*=12)
		5 (*n*=104)

*1 = Strongly Disagree / 2 = Disagree / 3 = Neutral / 4 = Agree / 5 = Strongly Agree

Of the 143 participants, 88% selected "Agree" or "Really Agree" tor the statement "I like math", most students agreed (*M*=4.37; *n*=143). A few of the students' comments included, "It helps me calculate numbers," "Math is a really fun subject and it helps us think," "I like maths because it is interesting," "It is very interesting for me and because I want to be an engineer when I grow up," and "No… because it's very hard to learn all the formulas." When presented with the statement, "Math is a very important subject," the average response pointed towards "Strongly Agree" (*M*=4.68; *n*=120). Finally, when shown the statement, "I want my math skills to grow," students again responded with "Strongly Agree" (*M*=4.8; *n*=120). In conclusion, most students from the current study enjoyed math, while many participants in grades 3-5 found math to be important and desired to improve in math.

Profile of iPad Usage

Parent participants were asked several questions related to their child's iPad use (see Table 2). When asked "how many hours a day does your child use the iPad for learning," the longest amount of time reported was 5 hours, the lowest was 0 hours, and the average time for the 62 parent responses was 1.95 hours.

Table 2. Parents' Profile of iPad Usage

Question	Participants (*n*)	Range (Lowest – Highest)	Response Average (*M*)
How many hours does your child use the iPad for learning?	*n*=62	0 hours – 5 hours	*M*=1.95 hours
How many hours does your child use the iPad for purposes other than learning?	*n*=62	0 hours – 5 hours	*M*=1.39 hours

Parents were also asked, "How many hours does your child use the iPad for purposes other than learning". The range of time was the same as for hours on the iPad for learning, but the average amount of time stated by the parents was 1.39 hours. During iPad use at home, parents reported their children mostly used apps to practice skills, worked on assignments or projects, and did research for assignments. A few parents also mentioned their children used the iPad to plan and/or organize information and write. Two of the 62 parents stated they did not have wireless internet access at home.

RQ1: In which ways did the iPad support learning?

Pros of the iPad

Participants were asked to rate three statements regarding the iPad, including (1) "The iPad can help me learn," (2) "I know how to use the iPad to learn math," and (3) "Using the iPad in math class makes math more

interesting" (see Table 3). Most students acknowledged the iPad can help them learn (*M*=4.41; *n*=120), verified knowing how to use an iPad to learn (*M*=4.38; *n*=143), and believed the iPad made math class more interesting (*M*=4.45; *n*=120).

Table 3. Pros of the iPad

Statement	Participants (*n*)	Response Average (*M*)*
The iPad can help me learn.	Grades 3-5 (*n*=120)	*M*=4.41 1 (*n*=5) 2 (*n*=3) 3 (*n*=2 4 (*n*=38) 5 (*n*=72)
I know how to use the iPad to learn.	Grades 3-5 (*n*=120) Grades 5-8 (*n*=23) Grades 3-8 (*n*=143)	*M*=4.25 *M*=4.17 *M*=4.38 1 (*n*=5) 2 (*n*=0) 3 (*n*=18) 4 (*n*=32) 5 (*n*=88)
Using the iPad in math class makes math more interesting.	Grades 3-5 (*n*=120)	*M*=4.45 1 (*n*=4) 2 (*n*=3) 3 (*n*=5) 4 (*n*=31) 5 (*n*=77)

*1 = Strongly Disagree / 2 = Disagree / 3 = Neutral / 4 = Agree / 5 = Strongly Agree

When students in grades 6-8 were asked, "What did you like about using the iPad in math class," comments included the "geometry pad," "the apps," "everything," and "I could take pictures of the sums and learn more about them at home." Most (83%) students did not feel math was harder when using the iPad because using the iPad made "it more easier," "it is helpful," "it is more fun to use the iPad in math class," and "we only do simple things in iPad."

Concepts and Problems

Participants were asked to rate three statements addressing concepts, problems, and grades in mathematics, including (1) "I understand the new math concepts better when I use my iPad," (2) "The iPad can help me solve

more difficult math problems," and (3) "I expect that I will get better grades in math when I use the iPad" (see Table 4). Most students agreed to understanding new concepts better when using an iPad (M=4.17; n=143) and to the iPad helping solve more difficult math problems (M=4.23; n=120).

Table 4. Concepts, Problems, and Grades in Mathematics

Statement	Participants (n)	Response Average (M)*
I understand new math concepts better when I use my iPad.	Grades 3-5 (n=120) Grades 5-8 (n=23) Grades 3-8 (n=143)	M=4.28 M=3.57 M=4.17 1 (n=2) 2 (n=8) 3 (n=19) 4 (n=49) 5 (n=65)
The iPad can help me solve more difficult math problems.	Grades 3-5 (n=120)	M=4.23 1 (n=4) 2 (n=9) 3 (n=6) 4 (n=38) 5 (n=63)
I expect that I will get better grades in math when I use the iPad.	Grades 3-5 (n=120) Grades 5-8 (n=23) Grades 3-8 (n=143)	M=4.15 M=3.74 M=4.08 1 (n=9) 2 (n=7) 3 (n=15) 4 (n=44) 5 (n=68)

*1 = Strongly Disagree / 2 = Disagree / 3 = Neutral / 4 = Agree / 5 = Strongly Agree

In support of the findings for understanding new concepts, students left comments such as: "Because it is effective and a good and different way of learning"; "Yes, since I get a teaching and learning support at home as well"; "I can understand both iPad and notebooks but a bit more in iPad"; and "Because it has better explanation on iPad than paper." Most students expected to get better grades in math when using the iPad (M=4.08; n=143). Students' comments included, "It helps me learn better," "It breaks it down to parts which makes me understand easier," "It helps me a lot," "It is good to use," "Because learning iPad with fun makes [me] more interested in the topic," "It makes me do it more," and "It's about how good I understand the concept which I understand better with iPads."

Students in grades 6-8 were asked open-ended questions regarding the use of iPads and learning math. The questions included: (1) "Do you feel the iPad helped you learn math? Why do you think this?" and (2) "If you answered yes, what topics did the iPad help you learn? How did the iPad help you?" Most students (67%) "Agreed" or "Really" agreed that the iPad helped them learn because of the apps. Students stated, "There are many apps to refer to" and "I control the new apps added to our iPad related to maths as it's very easy."
In terms of topics the iPad helped students learn, students mentioned: "Geometry," "the iPad helped me learn data handling and pi in mathematics," "data handling and visualizing solid shapes," "Kahoot," "Epic," and "I used the calculator a few times with the help of Siri, I got better at geometry."

Paper Worksheets vs iPad

In terms of comparing the iPad with paper worksheets, the participants were asked to rate two statements: (1) "When I learn a new math skill I prefer to use the iPad to practice than to use paper worksheets," and (2) "I like math more when I'm using an iPad instead of paper worksheets" (see Table 5).

Table 5. Paper Worksheets vs iPad

Statement	Participant (*n*)	Response Average (*M*)*
When I learn a new math skill, I prefer to use the iPad to practice than to use paper worksheets.	Grades 3-5 (*n*=120) Grades 5-8 (*n*=23) Grades 3-8 (*n*=143)	*M*=4.21 *M*=3.39 *M*=4.08 1 (*n*=5) 2 (*n*=13) 3 (*n*=15) 4 (*n*=43) 5 (*n*=67)
I like math more when I'm using an iPad instead of paper worksheets.	Grades 3-5 (*n*=120)	*M*=4.27 1 (*n*=4) 2 (*n*=6) 3 (*n*=13) 4 (*n*=28) 5 (*n*=69)

*1 = Strongly Disagree / 2 = Disagree / 3 = Neutral / 4 = Agree / 5 = Strongly Agree

Overall, students agreed (*M*=4.08; *n*=143) to a preference of using an iPad when learning a new math skill, but when separated, students in grades 5-8 had more a neutral opinion (*M*=3.39; *n*=23). Some participants' comments included, "It is more interactive," "Paper is wasting trees," "Because iPad contains more fun than worksheets," "It makes me do more," and "It is easy." Regarding more interest in math when using an iPad instead of paper worksheets, students agreed to preferring the iPad (*M*=4.27; *n*=120).

In terms of pros for iPad use (see Table 6), parents agreed with the following statements, "The iPad has increased my child's interest in technology" (*M*=3.84; *n*=63), "My child's teacher provides valuable and timely feedback because of the iPad" (*M*=3.57; *n*=63), and "My child is doing innovative activities (something not able to be done in the past) with the iPad" (*M*=3.79; *n*=63). Parents disagreed with the following statement, "My child can access more inappropriate content through the iPad" (*M*=2.37; *n*=63), which is actually a positive.

Table 6. Parents Pros for iPad Use

Question	Participants (*n*)	Response Average (*M*)*
The iPad has increased my child's interest in technology.	*n*=62	*M*=3.84 1 (*n*=1) 2 (*n*=8) 3 (*n*=10) 4 (*n*=25) 5 (*n*=19)
My child's teacher provides valuable and timely feedback because of the iPad.	*n*=62	*M*=3.57 1 (*n*=2) 2 (*n*=9) 3 (*n*=16) 4 (*n*=23) 5 (*n*=13)
My child is doing innovative activities (something not able to be done in the past) with the iPad.	*n*=62	*M*=3.79 1 (*n*=2) 2 (*n*=4) 3 (*n*=19) 4 (*n*=18) 5 (*n*=20)
My child can access more inappropriate content through the iPad.	*n*=62	*M*=2.37 1 (*n*=24) 2 (*n*=10) 3 (*n*=17) 4 (*n*=6) 5 (*n*=6)

*1 = Strongly Disagree / 2 = Disagree / 3 = Neutral / 4 = Agree / 5 = Strongly Agree

RQ2: What challenges did the students experience when using the iPad as a learning tool?

Cons of the iPad

Even though the majority of students acknowledged the iPad could help them learn, verified knowing how to use an iPad to learn, and believed the iPad made math class more interesting, not all students agreed. About a

tenth (9%) of students felt neutral or did not agree that the iPad can helped them learn because, although the iPad "helps in doing calculations," there is "too much to learn in maths." A few students (16%) reported not knowing how to use an iPad to learn, and 10% of students did not find the iPad made math class more interesting.

When asked, "What did you dislike about using the iPad in math class?," students in grades 6-8 responded with various comments, including "Geoboard," "I dislike using the iPad in math period because it don't have a calculator," "there is no google," "there are not more apps," and "because when you will be bigger you won't have the practice of practicing on the paper and you will have the practice of just a calculator." Rather than just knowing what students' disliked, students were also asked, "Is there a way the teacher can use the iPad differently next year to better help you learn math." The majority (78%) of students stated changes should be made with a few suggestions including, "more activities should be there and also google," "yes, we need access to the app store," "yes, we can make more PowerPoint presentations," and "yes, having more of math quizzes on critical thinking questions." Only a few (9%) of students found math to be harder when using the iPad, but one commented, "yes, because when you are showing your parents, it's harder to explain."

Concepts and Problems

Although most students chose "Agree" or "Really Agree" to understanding new concepts better when using an iPad (80%) and to the iPad helping solve more difficult math problems (84%), 20% and 16%did not find the iPad as beneficial," respectively. In support of the findings for understanding new concepts, students stated, "It helps in nothing," "It depends on the topic," "Sometimes I don't understand with the iPad and understand better with ma'am [teacher]," and "Sometimes we learn new in iPad and sometimes through books." Most students (78%) expected to get better grades in math when using the iPad, but 22% of students did not. Students not expecting better grades wrote statements including, "Neutral, since it is not just the iPad, but also our ability and determination," and "For math the iPad is not that useful" (see Table 4).

With 67% of students in grades 6-8 choosing to "Agree" or "Really Agree" that the iPad helps them learn math, the rest of the students had a "Neutral" feeling or chose to "Disagree." One-fourth (25%) of the students felt neutral about the iPad helping them learn math. The remaining students chose to "Disagree" with the statement of iPads being helpful in learning math stating, "It depends on the topic because I can learn in my home."

Paper Worksheets vs iPad

Approximately 3/4 of students (77%) selected "Agree" or "Really Agree" to a preference for using an iPad when learning a new math skill, leaving about a quarter of students (23%) not as optimistic." Some students mentioned: "It does not do anything to help"; "it is hard to do in iPads"; "while learning a new math skills, I prefer worksheets and live explanation"; "it makes me harder to understand"; "I prefer doing it in paper"; "because practicing on paper is better"; "for math skill paper can only help us," and "we can use paper for solving sums with rough work easily" (see Table 5).

Parent Cons of the iPad

The parent survey highlighted one main negative consequence of iPad use for their child's learning by agreeing with the following statement: "IPad usage has a negative impact on my child's handwriting skills" (M=3.65, n=63). When asked, "What would you change, if anything, about your child's iPad usage to increase its function as a learning tool, some parent comments included: "more writing tasks," "writing skills need to be improved," " provide more reading content and make the kids write more to improve the handwriting skills," and "more writing or typing assignments on the iPad for building up vocabulary and writing skills." Aside from comments about writing, parents also mentioned: "Would reduce the dependence on iPad to 60/40. Schools should identify the interest of the child and customize the learning experience to tailor their needs"; "provide more interactive apps"; "supply of books along with iPad"; "frequent training for parents and students on usage and assignments"; and "if addiction can be reduced, then it [iPad] is a good tool… Incorporate physical exercise app with completion goals."

Discussion

The study set out to examine in which ways the iPad supported mathematical learning and what challenges students experienced when using the iPad as a learning tool for learning mathematics.

iPad Support for Mathematical Learning

The current study revealed several areas of support for using the iPad as a learning tool for mathematical learning. Results show most students believed the iPad made math class more interesting, which confirms several previous studies examining the increase of motivation with tablet use (Kwak, 2017; Riconsenta, 2013; Zimmerman & Howard, 2013). Through comments on the surveys, students also demonstrated active learning and autonomy with tablets, which parallels the literature (Falloon, 2013).

When comparing worksheets to using an iPad, the majority of students preferred the iPad over worksheets. Student responses of math being more interesting and easier with tablets than with worksheets goes hand-in-hand with previous literature (Haydon, Hawkins, Denune, Kimener & McCoy, 2012; Maloney & Beilock, 2012). Parents from the current study agreed with research by Kwok (2017) which reported that integrating iPad use when learning mathematics allows teachers quicker student feedback. Riconscente (2013) included instant feedback as part of the solution for improved student performance in mathematics when using tablets.

Challenges Experienced Using the iPad for Mathematical Learning

Although several areas of support were found through the current study for using iPads with mathematical learning, some challenges were also discovered. Singer (2015) reported a lack of motivation when using iPad, while Kwok (2017) highlighted student motivation when using tablets, depending on the specific applications being used. The current study agrees with both researchers, as most students found the iPad to be motivating

when learning math, but some students disagreed. Most of the disagreement had to do with a lack of various applications on the iPad desired by the students. When asked how teachers could improve use of iPads for the learning of mathematics, students actually mentioned wanting access to the App Store.

Thought process may be better expressed when using tablet computers than with traditional tools (e.g., pencil, markers, paint, and paper) (Matthews & Seow, 2007; Milman et al, 2014), but the current study revealed about a quarter of participating students preferred natural materials. Preference and what actually works better are two different things, but student preference should always be taken into consideration when deciding if students should use tablets, solely, for each assignment, which was mentioned by one of the parents in the study: "Schools should identify the interest of the child and customize the learning experience to tailor their needs." Finally, parents strongly voiced a desire for more writing when the iPad is used for mathematical learning. Previous studies have shown an increase in communication when tablets are used (Keengwe, 2013), but parents of the current study wanted to see more physical writing to improve handwriting and composition skills.
In all, using the iPad as a learning tool for math learning seems to increase student motivation and assignment control, encourages autonomy, and is preferred by students over traditional worksheets. Parents confirm feedback is more instant, but want to see more physical writing being done when tablets are used in the classroom.

Limitations

The first limitation of this study is that it was conducted in a private school which already integrates tablets as a technology tool in its approach of teaching. Thus, the expectation is that both teachers and students have been trained to apply and implement ways to benefit the most from this device. Other schools may not have been fully able to integrate tablets or students may not be able to afford having tablets. In addition, teachers face another barrier with this method, which is the lack of proper training and support on how to fully benefit and adequately implement all the offered features and functions of the apps. Many tasks are required from teachers to have successful integration such as monitoring distractibility, progress, and limited indications of actual learning (Kwak, 2017). The second limitation of this study is the fact that it did not carry out a post-test to measure whether students really scored better results on their mathematics tests when compared to their previous scores. A delayed post-test would render straightforward evidence on the extent of the integration results.

Implications

iPads have the power of touchscreen technology, hold the promise of collecting individual students' performance data, organizing, and analyzing information to enhance individualized learning and expand teachers' visual hands-on math practice and ideas relative to students' abilities and progress. In reality, students never learn at the same pace nor demonstrate homogeneous potential cognitive performance; in fact, their growth is rarely linear (Hershberg & Robertson-Craft, 2009). Some learn more rapidly than others who need additional time, instruction, and/or extra practice. Therefore, an app that gathers and tracks each student's

learning data can assist students and send their teachers adaptable data according to the student's needs. In the light of these findings, there is a promise through the iPad's usage to enhance students' active engagement, improve differentiated instruction and practice, and develop the pedagogical practices of the mathematics teacher.

Conclusion

Students benefit more from independent and collaborative work with prompt feedback and differentiated support while using mathematics apps where they complete exercises, design books, solve problems, and create projects. The results presented in this study showed that iPads have a positive effect on teaching mathematics in schools. By increasing the interaction between the teacher and the students, classes became more dynamic and were accommodated very quickly according to the students' needs. Furthermore, students showed more engagement in the iPad class and their attention was sustained throughout their sessions. Student autonomy and self-esteem are stimulated when they are held responsible for their own learning while interacting with the tailored feedback on the tablet. These results will need a more in depth evaluation to confirm their durability over time in order to grant that results will not vanish once excitement dissipates.

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Appendix. Sample of Survey Questions

Parents

1. Do you have wireless Internet access at your home?
2. How many hours does your child use the iPad for learning?
3. How does your child use the iPad while at home?

Likart Scale Questions

1. My child is motivated to do homework because of the iPad.
2. My child studies more at home using the iPad.
3. My child reads more on the iPad.
4. My child is more organized because of the iPad.
5. The teacher - student cooperation became more effective after iPad usage.
6. iPad usage has reduced my child's interest in books .
7. iPad usage prevents my child from participating in social activities.
8. I cannot control my child's use of the Internet with the iPad.

Open- ended Question

What would you change, if anything, about your child's iPad usage to increase its function as a learning tool?

Grades 6-8 students

Demographics

What is your gender?

Open-ended questions

1. What did you like about using the iPad in math class?
2. What did you dislike about using the iPad in math class?

Likart Scale

1. When I learn a new math skill I prefer to use the iPad than paper worksheets.
2. I understand new math concepts better when I use the iPad.
3. I expect that I will get better grades in math when I use the iPad.

Grades 3-5

Demographics

What is your gender?

Likart Scale

1. Using the iPad in math class makes math more interesting.
2. I know how to use the iPad to learn math.
3. When I learn a new math skill I prefer to use the iPad to practice than to use paper worksheets.