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A Literature Review: The Effect of Implementing Technology in a High School Mathematics Classroom

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Abstract

This study is a literature review to investigate the effects of implementing technology into a high school mathematics classroom. Mathematics has a hierarchical structure in learning and it is essential that students get a firm understanding of mathematics early in education. Some students that miss beginning concepts may continue to struggle with mathematical computation and concepts throughout the educational experience. One learning strategy that can be implemented throughout the curriculum that can help students succeed in mathematics is the use of technology in the pedagogy of the classroom. To this end, this literature review is to stimulate reflection on the effect of using technology in the high school mathematics classroom since it can help engage students in the learning process, allow students to have a higher accuracy with computational tasks, help create a less-anxious mathematics environment for students, help motivate students, and help students get a deeper understanding of the mathematical content.

Keywords: Mathematics, Technology integration; Engaging students; Motivation; Curriculum

Introduction

Learning mathematics can be a struggle for some students and the methods that educators use in the classroom can make a huge impact on the level of understanding for the student. Educators recognize the need for different methods, strategies, curricula, and professional training that may be necessary to help meet the need in the pedagogy of students in mathematics. In the year 2000, the National Assessment of Educational Progress reported less than 20% of high school seniors had demonstrated a thorough understanding of the expected mathematical concepts (Young, Hodge, Edwards, & Leising, 2012). Since then there has been a slight improvement in mathematics scores in the United States since the United States Department of Education in 2013 reported approximately 26% of high school seniors had shown a strong knowledge with accuracy of the mathematical concepts (Perry & Steck, 2015). Although this improvement in mathematics scores, there is still a great need to continually evaluate what methods are working in the mathematics classroom and what changes may be necessary to continue to help students improve. Educators need to look at possible areas of improvement of the pedagogy of mathematics to a higher-order thinking that can help motivate and inspire students to learn not only the basics of mathematics, but to also to see the practical uses of mathematics in the real-world. One of these areas of improvement that can be used in the high school mathematics classroom is the use of technology by not only the teacher in the delivery of the content, but also by the students in the learning process. It is hypothesized that the use of technology in the high school classroom can have a positive effect on the engagement of the student, and thus improving mathematics understanding and test scores. Therefore, the purpose of the review is to investigate some studies in educational research that explored the impact of implementing technology in the classroom and how these changes may affect the mathematics classroom in the future.

Literature Review

In a 2015 research article, *Increasing Student Engagement, Self-Efficacy, and Meta-Cognitive Self-Regulation in the High School Geometry Classroom: Do iPads Help?*, by David R. Perry and Andy K. Steck four questions were addressed. First, what is the effect of including iPads as part of geometry course instruction on student engagement? Secondly, what is the effect of including iPads as part of geometry course instruction on student geometry standards proficiency scores? Thirdly, what is the effect of including iPads as part of geometry course instruction on student self-reported levels of self-efficacy? Lastly, what is the effect of including iPads as part

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of geometry course instruction on student self-reported levels of meta-cognitive self-regulation (Perry & Steck, 2015)? The study included 110 students along with two teachers that were broken up into two groups. One of these groups consisted of 57 students that used the iPad in the geometry classroom whereas the other 53 students were in the non-iPad group. The iPad was used as the technology integration tool because of its portability, internet access, and because it is a user-friendly device. Both groups in the study were taught the same material but the presentation of the material along with student interaction with or without the iPad was the distinction between the groups. The premise behind the use of the iPad group was to engage the student with the belief that student engagement will bring a greater understanding of the material. Data was collected through teacher observation, student self-reporting, and student surveys.

In response to the first question of student engagement, the iPad group confirmed the hypothesis since it was observed with a higher rate of student engagement when compared to the non-iPad group. This result could be because using technology such as an iPad in the classroom could enhance the attention of students simply because of the viewing of simultaneous information directly to the student (Brill & Galloway, 2007). Although student engagement was increased in the classroom with the use of iPads in the study, behavioral concerns with students on the iPads with non-academic activities had also unfortunately increased. The second question regarding the improvement of test scores actually resulted in negating the hypothesis since results showed a slightly higher academic outcome with the non-iPad group. The researchers attributed the results to the instructors' method of instruction, which was collaborative student learning and exploration. In addition, the instructor of the iPad group primarily used the iPad for drill and reinforcement, which could play a role in the lower test results. The third research question concerning the effect of the iPads with self-efficacy in the geometry classroom resulted in a slight increase that was reported by the students. The researchers were not sure if the positive results from the students were actually reporting self-efficacy of the geometry content or simply self-efficacy with the use of the iPad. IPads have become popular in the last five years because of its user-friendliness with the touch-screen pad, its portability, and its Wi-Fi accessibility that over 197 million iPads were sold in the year 2013 (Dogan & Almus, 2014). Students can use iPads for gaming and entertainment such as YouTube, but also students can use the iPad apps for educational purposes such as Showbie, Evernote, Remind101, Nearpod, Socrative, Notability, and Dropbox to name a few. In or out of the classroom, students using the iPad are engaged with the device, which could help students be more aware of the mathematical content that is being delivered in the classroom.

The primary reason of this study was to explore iPad integration in a geometry classroom to increase student engagement which then could result in higher tests scores, and higher levels of self-efficacy and meta-cognitive self-regulation. Although the use of the iPads may have some drawbacks that can be overcome, the increased student engagement in the classroom was observed. One of the implications of the study indicates that iPad professional training and pedagogy is important in not only content delivery, but for on-task student behavior as well. It is crucial for educators to have professional training in the use of technology so that the motivation behind the use of the technology is being transferred to the students (Rosas & Campbell, 2010). Further research is needed by educators to explore iPad integration in other mathematics courses along with different instructional methods. In addition, the iPads in this study were only used in the geometry class. Because of the limited use of the iPads, students could have been new to its use and the novelty could have had a factor as students were exploring the extent of the iPad. One possible solution to this could have been iPad integration throughout the curriculum in all subjects so that students would be familiar to the iPad. Integrating technology throughout the curriculum in all subjects allows students to be more engaged in the classrooms, and have more confidence in the technology, which may lead toward a greater confidence in the subject (Allsopp, McHatton, & Farmer, 2010).

In another research article by Chen-Chung Liu, Chien-Chia Chou, Baw-Jhiune Liu, and Jui-Wen Yang (2006), wireless technology was hypothesized to assist students in the learning process and to assist in the student-teacher interaction. This particular study attempted to answer three questions that could assist in understanding the use of technology in the mathematics classroom, and especially with hearing-impaired students. The first question is doing the wireless technology used in the classroom increase the student-teacher interaction? Secondly, did the use of the technology in the mathematics classroom enhance the learning of problem-solving techniques? Lastly, did the students adjust to the new technology? This study was conducted in a middle school classroom in Taiwan in one school year. There were 7 hearing-impaired students along with one hearing-impaired teacher that participated in this study. In general, the teacher in the classroom would use a whiteboard that would transfer to each student's tablet wherein each student could then work the problem individually and submit it back to the teacher. The teacher had the choice to view each student's work as a whole for the class to view or just send individual comments back to the student.

The accuracy of the mathematical problems before the use of the internet tablets and after the implementation of the internet tablets were compared quantitatively. In addition, general observations and student input through essays was qualitatively conducted. The results showed an increased student participation in the classroom along with students appeared to be more focused on the lesson. The outstanding outcome from this research was a 75% decrease in mathematical errors once the internet tablets were in use by the students. This confirms the hypothesis and implies that student interaction with the use of the technology, and not just the use of the technology by the instructor, can play a major role in the improvement of student engagement that results in a better accuracy of the mathematical concepts. In confirmation, the use of technology in a mathematics classroom can decrease mathematical errors since it helps students to focus more and have less idle time in the classroom (Wadlington & Wadlington, 2008). Although the sample size of the participants was small, and may question the validity of the results, the high decrease in mathematical errors should encourage mathematics instructors to use technology in the classroom. Further research may be needed to confirm this study, especially at different grade levels more than just middle school.

In another study by Stephen J. Hegedus, Sara Dalton, and John R. Tapper (2015) in the article *The Impact of Technology-Enhanced Curriculum on Learning Advanced Algebra in US High School Classrooms*, discovered the implementation of technology in a high school mathematics classroom is beneficial to not only student engagement, but also to student learning. The participants for this study consisted of 606 algebras 2 students and the teachers for those classes in 7 different Massachusetts' schools over a 2-year period. In this study, the technology curriculum, namely SimCalc, was implemented in all classes at random times within the year for varied lengths of time in place of direct instruction. SimCalc curriculum is designed for students to use individually or in small groups to increase student-teacher interaction, increase student engagement, and for students to create, adjust, and run simulations on different algebraic functions. The study focused on the potential of students learning algebraic concepts with a deeper understanding when compared to traditional direct instruction. Teaching students' algebra and the skills associated with problem solving techniques learned in algebra can have the potential to help students not just in algebra for that year, but also for skills needed post-high school since "high school algebra is a key predictor of college success" (Hegedus, Dalton, & Tapper, 2015, p. 204). The findings did support the hypothesis showing an improvement in student engagement, an improvement in teacher-student interaction, higher-order problem solving techniques were demonstrated, and student test results showed positive gains throughout the year when using the technology in the classroom.

This article focused primarily on the improvement of the student with the use of the technology in the classroom but did not consider the instructor as a possible factor in the findings. Likewise, the article had a limited study in one local area that could play a role in the findings. Researchers should also consider possible different results when used in different communities and with different ages of students. Curricula designed just for one subject may not be in harmony with other curricula that is designed specifically for the goal or focus of that school. Schools should have a curriculum that is technology driven throughout all grades, which is integrated throughout all subjects to allow uniformity and consistency for the students. This is confirmed by research that reports using technology across all subjects, especially at an early age, will help students to have more of a significant learning experience (Mativo, Womble, & Jones, 2013). If students are exposed early into a school-wide curriculum from elementary through high school that emphasizes the core subjects of science and mathematics along with integrating technology throughout all subjects, then it is more likely that the student will be more successful in science and math past high school to the collegiate level (Capraro & Nite, 2014).

Integrating technology early in education may allow the student to become more aware of not only how to use the technology, but also may give the student more confidence in the subject, especially mathematics. Another study confirmed this by reporting students felt more comfortable using technology since it allowed the student to be more accurate in mathematics. Although not all students feel comfortable using technology, most students in one study reported the use of technology alleviated some of the anxiety with mathematics and the anxiety associated with students taking tests (Meagher, 2012). If familiarity of using technology in the mathematics classroom can benefit students by allowing the students to feel more comfortable, then educators need to take the opportunity to incorporate technology in the pedagogy on a regular basis. Educators of course must have professional training to use the technology in the classroom and must feel comfortable using the technology themselves. The competence of the technology use by the instructor and the attitude of the instructor behind the technology can have the most effective action toward the success of the mathematics in the classroom (Yu-Liang, 2011).

More research confirmed this by stating that teacher attitude with technology integration and successful implementation of technology in the classroom can be more significant than any other factor when incorporating technology into the curriculum (Nicholas & Ng, 2012). Administrators, curriculum leaders, and teachers need to have professional training in technology, be supportive of the process of technology integration, and be willing to assist others in the use of technology throughout the curriculum since "technology cannot be grafted onto existing curricula; it must be integrated thoughtfully" (Parkay, Anctil, & Hass, 2014, p. 49).

Conclusion

Learning mathematics, especially early in education, is crucial to the development of a student's mathematical abilities as the student progresses through the educational process. Mathematics concepts are hierarchical in content where one topic must be understood before the next topic is introduced. If students miss key components of one topic, then that could hinder the student fully grasping not only that concept, but also the concepts to follow. Students need to be engaged in the learning of mathematics, and it is a necessity that educators use methods in the classroom that will help in the process of student engagement to help motivate the students to get a deeper understanding of mathematics. If students stay motivated in the pedagogy of the learning process, then students will more likely be successful in mathematics, and this is especially likely for male students (Erdem-Keklik & Keklik, 2013). One strategy to help in this process is to implement technology throughout the curriculum and especially in the mathematics classrooms. Using technology in the classrooms, as the studies suggested, can increase student engagement, increase motivation to learning, allow for better teacher-student interaction, support student collaboration, assist in the accuracy of mathematical computation, and help students not only feel more comfortable with learning mathematics but also allow for a deeper understanding of the mathematical concepts. The positive effect of using technology throughout the curriculum can assist student learning mathematics to higher-order thinking that can help students even beyond the classroom. To this extent, the use of technology within the curriculum from elementary to high school is necessary for the betterment of learning mathematics. Finally, it is expectant that educators will continue to use technology in new ways in the classroom to help students be prepared for today's ever-changing technology driven society.

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