Impacts of Technology in the Math Classroom

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I. Introduction

The impact of technology in the classroom has been a topic of interest for many educators for years about whether it has a positive or negative effect on the students' learning. Since the global pandemic of COVID-19 hit in 2020 technology has become even more widely discussed within the teaching communities. This review analyzes students learning outcomes to determine if their grades or scores improved from the use of technology in the classroom.

II. Theme 1: Integration of Technology in Math Education

Subheading 1-1 - History on technology in the math classroom

Article Title: "The Evolution of Technology for the Mathematics Classroom"

Authors: Meeker, K., & Thompson, P.

Journal: TechTrends

Publication Year: 2023

Abstract/Summary: This article explores the history and evolution of two distinct technologies in the mathematics classroom: presentation tools and calculating tools. Presentation tools began with chalkboards/blackboards in the late eighteenth century where teachers used chalk to write math problems on the board to be solved by students on their slates and eventually teachers have used white boards in placement of chalkboards. Another presentation tool was a projector and most recently the interactive boards. The interactive boards are a tool math teachers use in varying ways including games and lectures. The calculator is another tool which has evolved from the abacus and eventually had calculators in the cell phone. Both of these technologies have advanced over the centuries and changed the educators classroom practices during this time.

Subheading 1-2 - Various technologies in the math classroom

1. Article Title: "Mobile-phone-based classroom response systems: Students' perceptions of engagement and learning in a large undergraduate course"

Authors: Dunn, P. K., Richardson, A., Oprescu, F., & McDonald, C.

Journal: International Journal of Mathematical Education in Science and Technology

Publication Year: 2013

Abstract/Summary: Using Classroom Response System (CRS) fosters engagement and positive educational outcomes while using the students mobile phone. It allows for students and teachers to respond quickly which also allows for everyone to be heard. Students shared they felt more comfortable without speaking up in front of everyone to give an answer to the professor. It is a quick way for the teacher to analyze what students are understanding in the classroom. It improves a plethora of things for the class: student's attitudes, attendance, engagement, interacting between instructor and students especially in larger classroom settings, and allows the student to remain anonymous. Though there are challenges such as cost or students who do not have a mobile device to participate in the activity.

2. Article Title: "Teaching and learning of inclusive and transitive properties among quadrilaterals by deductive reasoning with the aid of SmartBoard"

Authors: Leung, I. K. C.

Journal: ZDM

Publication Year: 2008

Abstract/Summary: The article here describes how a teacher took a geometry lesson and used it on a Smartboard (SB) to help students be able to look and identify a shape accurately. The visualization available on the SB was used to help produce different representations quickly and efficiently for students to see. Another way the teacher used the SB was manipulating the figure. The SB allowed the figure to be manipulated. The student saw that the geometric figure was not being redrawn a different way rather it was manipulated by imposing or relaxing constraints. In this way, students could use deductive reasoning to decide which quadrilateral was displayed on the SB.

Subheading 1-3 - Benefits of integrating technology into the math classroom

1. Article Title: "Benefits of adaptive lessons for pre-class preparation in a flipped numerical methods course"

Authors: Clark, R. M., & Kaw, A. K.

Journal: International Journal of Mathematical Education in Science and Technology Publication Year: 2020

Abstract/Summary: This article focuses on numerical methods flipped classroom experience. The instructors noticed the challenge within the flipped classroom is preparing the class for all. This does not meet the needs of all students and has a lack of differentiation. One way to solve this problem is through a personalized adaptive platform. "The adaptive platform provides personalized, flexible learning with multiple resources, including videos, text, quizzes, and simulations, with different paths depending on a student's progress." Personalized adaptive lessons tend to be well liked by students when taking a class modeling the flipped classroom. When lessons are individualized students tend to do better by seven points compared to the non-adaptive group. Seventy-one percent (71%) of students surveyed said the adaptive lessons were helpful to their success in class. Students also said they prefer this method over the typical flipped classroom. 2. Article Title: "Investigation of the effect of computer-supported instruction on students' achievement on optimization problems"

Authors: Çekmez, E.

Journal: International Journal of Mathematical Education in Science and Technology Publication Year: 2023

Abstract/Summary: "This study aimed to investigate the relative effectiveness of a computer-supported teaching sequence in solving optimization problems in calculus compared to a traditional teaching approach." There was a controlled and experimental group. The controlled group received the direct lecture while the experimental group received instructional intervention. The researcher contributes two factors to the experimental's success in the study. One, utilizing computers to help solve the comprehension questions. Two, they had a whole group discussion about the comprehension questions.

III. Theme 2: Effects of Technology on Student Engagement and Achievement

Subheading 2-1 - Academic digital games in math for engagement and achievement

1. Article Title: "Improving master of fractions by blending video games into the Math classroom"

Authors: Masek, M., Boston, J., Lam, C. P., & Corcoran, S.

Journal: Journal of Computer Assisted Learning

Publication Year: 2017

Abstract/Summary: Fractions in the primary level are a key indicator as to whether students will be successful in upper mathematics. In this research the teachers are giving instruction as usual regarding fractions in Year 6 for both the control group and the intervention group. The intervention group is also getting a game titled "The Abydos Game" which covers fractions. The game has varying levels to pass through to practice about least common multiple, speed and accuracy to complete a problem, and finding the sum of fractions. The intervention group was asked during the four week trial to utilize the game for two, twenty minute sessions per week. By the end of the four weeks the average amount of game time was 65 minutes. The results for the intervention group were greater than the control group once they had taken the post test. Integrating digital games into the math classroom is a way to improve knowledge of mathematical knowledge.

2. Article Title: "Learning Math with Curious George and the Odd Squad: Transmedia in the Classroom"

Authors: McCarthy, E., Tiu, M., & Li, L.

Journal: Technology, Knowledge and Learning

Publication Year: 2018

Abstract/Summary: This article included two studies which concentrate on transmedia (digital and non-digital) activities in the math setting for preschool and first grade. The studies included teacher instruction, parent information along with digital and non-digital activities to be used at home, and narrative based problem solving in digital games and non-digital activities at school. Teachers reported in their post interviews that the engaging narrative based problems were motivating for students. Teachers saw students' motivation as both persistent and positive with the adaptive scaffolding utilized in the math activities throughout the study. In both studies, the outcomes were both positive from the pre- to post-assessment.

Subheading 2-2 - Technology provides personalized learning and adapts to students' needs

1. Article Title: "Exploring the use of educational technology in primary education: Teachers' perception of mobile technology learning impacts and applications' use in the classroom" Authors: Domingo, M. G., & Garganté, A. B.

Journal: Computers in Human Behavior

Publication Year: 2016

Abstract/Summary: Mobile technology is just one way learning takes place utilizing technology in the classroom. Marta Gomez Domingo and Antoni Badia Garganté touch on how mobile technology has made a worldwide impact on learning in the classroom. One of the biggest impacts of mobile technology is the promotion of collaborative learning being used in the classroom. Collaborative learning increases learning through peers and teachers in the classroom along with positive, helpful comments. Internet resources were easily accessible when having the mobile device in hand when conducting research for projects. To summarize, "...teachers' perceptions focused on five different kinds of impacts of mobile technology in learning; Providing new ways to learn, increasing engagement to learning, fostering autonomous learning, facilitating access to information, and promoting collaborative learning."

2. Article Title: "Exploring Teachers' Use of Tablet Technology in the Classroom: Tools for Motivating At-risk Learners"

Authors: Dees, L., LaCour, M., & Lockwood, R.

Journal: The International Journal of Technologies in Learning

Publication Year: 2017

Abstract/Summary: Technology can adapt to what a student needs. In this study, research through surveys was conducted to examine the motivation and engagement of tablets being utilized in the classroom. Many students seemed motivated and had a positive outlook towards tablets being

used in the classroom with 78% used in a reading class and 61% being used in the math class. Tablet use is for skill building rather than a lesson.

Subheading 1-3 - Technology's effect on students' problem-solving skills and mathematical reasoning

Article Title: "Narrative-supported math problem solving in digital game-based learning"

Authors: Dai, C.-P., Ke, F., & Pan, Y

Journal: Educational Technology Research and Development

Publication Year: 2022

Abstract/Summary: The study shows that students are successful at narrative game play through digital game based learning (DGBL). The games offer a storyline to keep the student engaged. They also offer feedback to allow the student to understand the "...consequences of learners' decision making." When students are able to understand their math thinking through narrative-based game play they are able to take the consequences and refine their thinking to grow new dendrites about how the math works or does not work. When utilizing DGBL in the classroom it allows for students to problem solve in ways they may not have been able to in the classroom alone with worksheets. When utilizing DGBL there can be real life scenarios acted out; not just a word problem read from a two dimensional paper. The work being completed in the DGBL could also be considered a productive failure. One concern brought to attention was that students may not realize that since this is a game the scenarios may not relate to real life.

IV. Theme 3: Barriers and Considerations in Implementing Technology in Math Education

Subheading 3-1 Challenges and barriers faced by educators in the math classroom with technology

 Article Title: "THE PRACTICALITY OF IMPLEMENTING CONNECTED CLASSROOM TECHNOLOGY IN SECONDARY MATHEMATICS AND SCIENCE CLASSROOMS" Authors: Shirley, M. L., Irving, K. E., Sanalan, V. A., Pape, S. J., & Owens, D. T. Journal: International Journal of Science and Mathematics Education

Publication Year: 2011

Abstract/Summary: Within the research conducted in the math and science classrooms in this study of the use of connected classroom technology (CCT), many teachers faced challenges with the instruments not working correctly or connecting when students were using. The students were unable to connect when they needed to submit their responses at the moment. "The presence of support systems, such as technology experts and a community of learners, was important in the present study to help teachers overcome specific implementation barriers." There were barriers to make sure the CCT would up and run on its own without the support of an expert to keep it going when there were glitches. The challenges and barriers from this study seemed to stop some teachers from utilizing the CCT.

2. Article Title: "Effects of Playing an Educational Math Game That Incorporates Learning by Teaching"

Authors: Fiorella, L., Kuhlmann, S., & Vogel-Walcutt, J. J.

Journal: Journal of Educational Computing Research

Publication Year: 2019

Abstract/Summary: In this article a study was conducted to test the effects of implementation of a narrative computer-based game in a middle school math class. The students we pre-tested and

post-tested for instruction. The game explored a spaceship and used an avatar to help solve math word problems. The study lasted for four days. There was a control group which received the conventional math lesson and the game group who had about 10 hours of gameplay. The study found there was no significant difference between the two groups. The challenge was found in that students on the narrative computer-based game only spent 20% of their time actually playing the game with learning by teaching features. This was the main intention when playing the game. The students spent the 80% of their time navigating the virtual world.

• Discuss factors such as teacher training, access to technology, equity issues, and resistance to change.

Subheading 3-2 Teacher training

 Article Title: "Learning to Integrate Technology in Early Math Classrooms: An Empowering Collaborative Learning Experience"

Authors: Larsen, S. M., McCormick, K., Coburn, L., & Henry, C.

Journal: Childhood Education

Publication Year: 2023

Abstract/Summary: Many teachers attend Professional Learning Communities (PLC) to refine their teaching skills. In this study, teachers solved how to engage students utilizing technology in the math classroom through screencasting. By the end of this study, students were explaining how to solve a math problem on a recording using a screencast because they were given tools to show their mathematical thinking, time to think to solve, problems with high interest, and they felt their voice was heard within their classroom. They also learned how to demonstrate the use of varying applications on their device with various math tools such as tens frames and number lines. Before, during, and after the screencasting was taking place in the classrooms, teachers were in PLC meetings to communicate and actively engage with other colleagues, administration, and academic coaches to bring the best teaching to their classroom. New teachers are coming in with digital savvy skills as digital natives, but they lack the know-how on integrating technology in the classroom while students are learning. This is not due to a lack of technology knowledge but rather a lack of knowing how to integrate it into the classroom from not being modeled how to do so from the previous generation of teachers they watched teach them as they grew up. Teachers being trained on technology and how to integrate into the classroom is a key factor in student learning.

2. Article Title: "Preparing children for success: integrating science, math, and technology in early childhood classroom"

Authors: Kermani, H., & Aldemir, J.

Journal: Early Child Development and Care

Publication Year: 2015

Abstract/Summary: Children begin to learn about math at an early age. Children are in need of learning and playing with numbers, patterns, shapes at an early age especially children with low socioeconomic backgrounds. It goes on to say that teachers need to do away with the thinking that math (and science) are for only smart and white lab coat wearing people. This is simply not true. Everyone can be a mathematician (and scientist) in everyday life. The study took pre-kindergarten, economically disadvantaged and disabled children from four different classrooms and gave the teachers more training over technology integrated into the math and science subject areas and technology to use in the classroom such as laptops to play games on and conduct research. Teachers trained students to realize that if they had a question about something related to nature that students should "google" that or research the topic on the

internet. By the end of the research, students showed growth more so than the controlled group which did not have access to the technology or teachers with the training given. When children are given a teacher who utilizes the tools they have been given to teach children, the children are more likely to think like mathematicians.

• Explore best practices and strategies for overcoming these barriers and making effective use of technology in math education.

Subheading 3-3 - Overcoming barriers of technology in math education

Article Title: "Creative approaches to teaching mathematics education with online tools during COVID-19"

Authors: Livy, S., Muir, T., Murphy, C., & Trimble, A.

Journal: International Journal of Mathematical Education in Science and Technology Publication Year: 2022

Abstract/Summary: In March of 2020, COVID-19 required schools around the world to close down, including for pre-service educators. When this happened students all over the world were learning from the comfort of their own home. Educators were all of a sudden figuring out how to teach online with little to no experience. Students were used to on-campus classes, hands on activities, concrete representations to scaffold their thinking and learn complex content. The challenge was to teach the same content at the same rigor, but the question was how since schools and universities were close down. The educators were up for the challenge and used SAMR model. The SAMR model: "S" is substitution - technology acts as a direct substitution with no functional change, "A" is augmentation - technology acts as a direct substitution with functional improvement, "M" is modification - technology allows for significant task redesign, and "R" is redefinition - technology allows for the creation of new tasks, previously inconceivable. They found that challenges they had as online teachers quickly became ways that were eventually used on a daily basis by utilizing new technology.

V. Conclusion

The discussions that educators take from these articles is that students can learn with the aid or use of technology helps keep the engagement high, know that technology does not need to be used everyday yet used when appropriate for students to be successful (skills based or using a teaching model such as SAMR), and providing feedback for students when they are learning on their own. Technology is here to stay. Educators are realizing this is how the future will be and that students need to know how to use technology in a way which provides structure and motivation for the student to want to keep learning.

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