

The Integration of Technological Devices in Mathematics Education: A Literature Review

Hamdi Serin¹

¹Department of Business and Management, Faculty of Administrative Sciences and Economics, Tishk International University, Erbil, Iraq

Correspondence: Hamdi Serin, Tishk International University, Erbil, Iraq

Email: hamdi.serin@tiu.edu.iq

Doi: 10.23918/ijsses.v10i3p54

Abstract: The emergence into the new era requires teachers to employ technological devices to meet the requirements of their students in mathematics education. The incorporation of technology into mathematics learning has the potential to promote teaching and learning of mathematics because these devices can increase effectiveness by means of their features. The use of technology in mathematics education can foster thinking skills, achievement, motivation, and self-efficacy of learners. Mathematics learning requires logical reasoning and problem-solving abilities. Through using textbooks, it is not easy to develop these skills of students; however, technological tools can create an authentic learning environment for students in which they experience learning and promote deeper understanding of mathematical concepts. This article explores the benefits of employing technology in mathematics education.

Keywords: Mathematics, Technology, Incorporation, Learning, Skills

1. Introduction

Mathematics is a fundamental subject that cultivates critical thinking skills, logical reasoning, and problem-solving abilities, which are of paramount importance in various fields such as science, engineering, and technology. Mathematics is the foundation of knowledge and an indispensable tool to foster creativity that helps with finding innovative solutions to complicated problems. Moreover, it plays a crucial role for learners to make informed decisions, analyze data and predict outcomes for success in the modern world.

With the advent of technology, the way we teach and learn mathematics has greatly changed. Today a great many schools use technological devices to facilitate learning. A great number of research found that teaching mathematics with technology can enhance learning (Bray & Tangney, 2017; Hillmayr et al., 2020; Olsher & Thurm, 2021). These studies have made it clear that the implementation of technological devices in mathematics classroom can greatly contribute to creating an effective learning environment and student learning.

Received: March 29, 2023

Accepted: May 20, 2023

Serin, H. (2023). The Integration of Technological Devices in Mathematics Education: A Literature Review. *International Journal of Social Sciences and Educational Studies*, 10(3), 54-59.

The use of technology has become a need for schools and teachers to meet the needs of students' learning (Abiog, 2022). In the meantime, teachers' knowledge and beliefs are important factors in integrating technology into mathematics education. Rubin (1999) suggested that the inclusion of technology into mathematics teaching has "rich potential, significant obstacles, and important concerns" (p. 19). Although technology offers several opportunities to enhance teaching and learning in mathematics, it has also some challenges and difficulties. The availability of technological devices in classrooms, professional development of teachers and administration are also important factors that may affect the integration of technology into mathematics education. Based on these ideas, the appropriate use of technological devices holds a very significant place for effectiveness. NCTM (2000) states that:

The effective use of technology in the mathematics classroom depends on the teacher. Technology is not a panacea. As with any teaching tool, it can be used well or poorly. Teachers should use technology to enhance their students' learning opportunities by selecting or creating mathematical tasks that take advantage of what technology can do efficiently and well--graphing, visualizing, and computing (pp. 25-26).

Nevertheless, the use of technological tools in education can make learning more meaningful and more interesting. The implementation of technology into education has the potential to make teaching and learning more effective and efficient. Technological devices have a significant impact on learning and teaching as it makes the content more expressive, creates more time for teachers for group instruction and increases collaboration. Technology offers numerous benefits that can enhance students' learning experiences. For instance, technology can create an authentic learning environment in the mathematics classroom. Also, it connects the concepts to the real world and helps learners with conceptualization and better comprehension.

Technological devices provide interactive and engaging learning environment for learners in which they can visualize abstract concepts, enjoy learning, and develop a deeper understanding of mathematical concepts. Through technology, learners can progress at their own pace; thus, it fosters personalized learning. It is true to say that learners become more autonomous while learning mathematics via technology. In addition, teachers can create an authentic learning environment for learners in which learning becomes facilitated. Also, technology can create a supportive learning environment in which learners can analyze their strengths and weaknesses. Usun (2004) also makes it clear that technological tools especially the penetration of computers into education is the most effective interactive platform and thus can create new approaches that can facilitate understanding.

Technology promotes collaborative learning. The integration of technology in mathematics classroom can facilitate communication and collaboration among learners. Learners while problem solving can share ideas and develop their critical thinking skills. This encourages active participation and peer-to-peer learning. A cooperative approach to problem solving enhances teamwork and communication. Learners by means of collaboration work together and try to find creative solutions to achieve a common goal. While doing this, their engagement is promoted as they are encouraged to exchange ideas and perspectives. They support one another, benefit from the others' strengths, and learn about different problem-solving strategies.

2. Literature Review

Mathematics is a complicated subject for some students to understand. That being the case, it is also hard for teachers to explain it to students. National Research Council (NRC) (2001) states that the expectations from mathematics teachers is to enhance “elaborated, integrated knowledge of mathematics, a knowledge of how students’ mathematical understanding develops, and a repertoire of pedagogical practices that take into account the mathematics being taught and how students learn it” (p. 381). Mathematics teachers are expected to know the curriculum and effective instructional strategies to foster learning. Despite its difficulties, teachers can use various strategies to make mathematics learning easy to understand for students.

A broad spectrum of innovative tools and platforms have emerged recently to support mathematics education and provide teachers with effective teaching resources. Effectiveness in mathematics teaching is important to foster learning and “effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well” (National Council of Teachers of Mathematics, 1991, p. 20). Strickland and Coffland (2004) defines effectiveness in mathematics teaching as giving constant support for authentic applications of mathematics. National Council of Teachers of Mathematics (2014) states that effective instruction in mathematics “engages students in meaningful learning through individual and collaborative experiences that promote their ability to make sense of mathematical ideas and reason mathematically” (p. 7). Apparently, effectiveness holds a very significant place in mathematics education and the integration of technology into mathematics classroom plays a critical role in increasing effectiveness.

Several technologies can be employed to enhance the teaching of mathematics. While interactive whiteboards allow teachers to display and manipulate mathematical concepts in real-time, educational software and mobile applications offer quizzes, mathematical games, and interactive lessons to learners anywhere. Moreover, online learning platforms and video tutorials provide opportunities for learners to access resources they need. These resources also give immediate feedback which learners can use for further development. Additionally, online collaboration tools and discussion forums create learning environments in which learners work together and engage in problem-solving activities. It should be noted that learner engagement is a prior issue in learning because "goals are best served by the creation of communities of learners in which students are actively engaged in the process of mathematical sense making" (TERC, 1999, p. 3). The use of technological devices can encourage learners to engage in the learning process (Momani, 2023). These devices can intrinsically motivate learners to involve in mathematical thinking (Zbiek et al., 2007). Through technological devices learning becomes interesting; hence, the level of motivation

The use of these technological devices in mathematics learning and teaching enables teachers to enhance classroom instruction and present mathematical concepts dynamically. Graphing calculators and software programs like GeoGebra can create a learning environment for learners in which they experiment with mathematical concepts and develop a deeper understanding of them. Furthermore, these tools can enhance problem solving skills of learners through enabling them to explore mathematical relationships. Teachers use technological devices in four different areas while teaching mathematics Niess et al. (2009, p. 18-19):

- 1) Designing and developing digital-age learning environments and experiences – Teachers employ digital age devices to enhance mathematics learning
- 2) Teaching, learning and the Mathematics curriculum – Teachers incorporate appropriate technological devices to promote learning
- 3) Assessment and evaluation – Teachers use technological devices for assessment and evaluation purposes
- 4) Productivity and professional practice – Teachers implement technological devices to increase effectiveness and productivity and their professional practice

In addition, virtual reality (VR) and augmented reality (AR) applications can also encourage learners towards engagement into mathematical environments. VR simulations can help learners visualize abstract concepts by means of showing a realistic representation of the mathematical models. AR, on the other hand, overlays virtual objects onto the real world. This feature of the application facilitates understanding of mathematical concepts. The comprehension of mathematical concepts is not always easy for learners. Very often, learners may need support to understand these concepts while solving problems. However, the use of technological devices can not only enable learners to understand concepts better but also help them solve the problems with ease.

Technology is used to facilitate instruction and learning in mathematics education. Teachers can implement technological devices in mathematics education for:

- 1) Exchanging ideas while teaching mathematics
- 2) Accessing Internet sources for practice
- 3) Presenting mathematical concepts
- 4) Using graphical software
- 5) Saving more time in the classroom
- 6) Designing solutions to problems
- 7) Using databases, documents or follow-up charts
- 8) Manipulating figures, data or graphs for making them easy to understand

The integration of technological devices is also quite useful for teachers because these tools help teachers organize their course materials, assignments, and assessments. With the help of these tools, teachers can monitor the progress of their learners, provide them feedback, and identify areas learners need for improvement. It is evident that the implementation of technological devices provides several benefits for both teachers and learners. While teachers use them for providing effective instruction, learners use them to understand mathematical concepts easily.

The benefits of implementing technological devices in mathematics teaching can be summarized as:

- 1) They can enhance reflective thinking
- 2) They can foster critical thinking

- 3) They can promote problem solving abilities
- 4) They can provide opportunities for collaboration and interaction
- 5) They can develop constructive learning
- 6) They can link the mathematical concepts to real-world situations
- 7) They can create a learner-centered learning setting
- 8) They can facilitate comprehension of mathematical concepts
- 9) They can help learners visualize abstract concepts
- 10) They can increase effectiveness in mathematics learning and teaching
- 11) They can develop logical reasoning
- 12) They can promote motivation
- 13) They can turn make learning fun and engaging
- 14) They can enhance teamwork and peer to peer learning
- 15) They can foster personalized learning
- 16) They can help learners experiment with mathematical objects

3. Conclusion

Today technology has revolutionized the way mathematics is being learnt and taught. Mathematics teaching is no longer conducted using textbooks and boards. Instead, technological devices have been extensively implemented in mathematics education to foster effectiveness. Virtual simulations, collaborative environments have led mathematics education to an engaging, inclusive, enjoyable, and personalized learning experience. The use of these devices is a powerful supplement to foster instruction and learning. Mathematics develops critical thinking skills and problem-solving abilities. Although some learners may encounter difficulties in understanding mathematical concepts, embracing technological advancements impacts mathematics education and allows learners to become confident problem solvers and critical thinkers.

References

- Abiog, E. B. (2022). Online reading and viewing in higher education: The case of university students in the Philippines. *Canadian Journal of Language and Literature Studies*, 2(3), 36–53.
<https://doi.org/10.53103/cjlls.v2i3.46>
- Bray, A., & Tangney, B. (2017). Technology usage in mathematics education research—A systematic review of recent trends. *Computers & Education*, 114, 255–273.
- Hillmayr, D., Ziernwald, L., Reinhold, F., Hofer, S. I., & Reiss, K. M. (2020). The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis. *Computers & Education*, 153, 103897. <https://doi.org/10.1016/j.compedu.2020.103897>

- Momani, L. (2023). With high-quality online learning integrated into campuses in each major students are motivated to earn their degrees, and compensate for emergencies. *Canadian Journal of Educational and Social Studies*, 3(1), 29–37. <https://doi.org/10.53103/cjess.v3i1.105>
- National Research Council. (2001) (NRC). Adding it up. Washington, DC: National Academy Press.
- National Council of Teachers of Mathematics. (1991). Professional standards for teaching mathematics. Reston, VA: Author.
- National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics. Reston, VA: Author.
- National Council of Teachers of Mathematics. (2014). Principles to Actions: Ensuring Mathematical Success for All. Reston, VA: Author.
- Niess, M. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education*, 21, 509–523.
- Olsher, S., & Thurm, D. (2021). The interplay between digital automatic-assessment and self-assessment. In M. Inprasitha, N. Changsri, & N. Boonsena (Eds.), Proceedings of the 44th conference of the international group for the psychology of mathematics education (Vol. 3, pp. 431–440). PME.
- Rubin, A. (1999). Technology meets math education: Envisioning a practical future. In U.S. Department of Education, 1. Retrieved from the World Wide Web http://eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/17/0a/50.pdf. Accessed 15 February 2008.
- Strickland, A., & Coffland, D. (2004). Factors related to teacher use of technology in secondary geometry instruction. *Journal of Computers in Mathematics and Science Teaching*, 23(4), 347-365. Norfolk, VA: Association for the Advancement of Computing in Education (AACE). Retrieved April 8, 2018 from: <https://www.learntechlib.org/primary/p/21757/>
- TERC. (1999, December). Technology meets math education: Envisioning a practical future in education. [Electronic version], Cambridge, MA: Rubin, A. Retrieved October 2, 2005, from ERIC database.
- Usun, S. (2004). Undergraduate students attitudes on the use of computers in education in educational studies in mathematics, 56, pp.125-135.
- Zbiek, R. M., Heid, M. K., Blume, G. W. & Dick, T.P. (2007). Research on technology in mathematics education. In F. K. Lester Jr. (Ed.), Second handbook of research on mathematics teaching and learning. (pp. 1169-1207). Charlotte, NC: Information Age Publishing.