A Critical Review of Technology Embedded Learning for Mathematics Learning

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DOI: https://dx.doi.org/10.51584/IJRIAS.2025.101100060

Received: 01 December 2025; Accepted: 07 December 2025; Published: 13 December 2025

ABSTRACT

The integration of embedded technology in mathematics learning has significantly influence modern practices. These days technological tools are quite helpful for teaching and learning. The use of technology in the classroom has grown in 21st century. As the demand on education in the modern age continue to rise, many forms of technology are having an enormous effect on classroom teaching. Technology must be used into actual classroom in order to improve students understanding in mathematics as well as critical thinking, problem solving ability, Therefore, it is essential to successfully embedded technology in mathematics instructions. Through the use of technology, we organized the classroom effectively and efficiently. According to Wei (2020), the technology-embedded classroom approach includes various forms of technology use in teaching. i.e., The technology- embedded classroom approach including technology assisted teaching, technology integrated teaching and technology- based teaching. However, challenges still exist during teaching and learning, without using technology, teacher may struggle to effectively deliver topic such as co-ordinate geometry, geometry, mensuration, circle etc. Additionally, students may bore during class while teaching by traditional method. Technology-embedded learning in mathematics offers many advantages. A technology-integrated classroom provides flexibility for both learners and instructors, allowing students to grasp topics with both abstract and concrete thinking. But it has many challenges too, such as high cost of technological tools, integration of mathematical tools, accessibility, lack of digital literacy etc. This paper critically reviews the role of technology for mathematics learning, explore its benefits and challenges and suggest some solution to integrate embedded technology in normal classroom for mathematics learning.

Keywords: Embedded Technology, ICT Integration, Mathematics Learning

INTRODUCTION

Mathematics is an essential academic subject that depends more on abstract thinking, problem-solving, and logical reasoning. Traditional mathematical teaching methods focus predominantly on rote memorization and repetitive practice. They may not fully engage all students or address their diverse learning needs. The incorporation of technology has been suggested to make changes in math instruction by offering ways to engage more students, provide interactive learning experiences, increase the fun aspects of learning, and facilitate individualized learning of each student. In these times technology has become most addicted to everyone. It has significantly influenced the field of education; it has transformed the way of teaching and learning. Technology's greatest strength is its capacity to increase students' motivation to learn by offering dynamic and captivating educational opportunities. Mathematics a subject often considered challenging many students faces difficulties to solve problem. It is often perceived to be complex and difficult. For learning mathematics, technology-embedded learning devices play a significant role rather than traditional textbooks. Like Graphing applications, computer algebra systems, interactive simulations, and AI-tutored systems provide digital means for studying mathematical concepts. These technological advances have brought about new ways

of engaging learners, personalizing instruction, and fostering deeper conceptual understanding. Technology embedded learning has been integrated to provide individualized dynamic, students-centred learning environment, gave flexibility to learn from own pace. Traditional methods of teaching mathematics provide students to direct instruction, rote memorization which may rarely fulfil the different demands of learners. while these strategies have demonstrated helpful for some learners, but they frequently fail to provide the engagement and adaptation required to meet different learning style. Alternative methods that prioritize visualization, interaction, and practical applications have been made possible by the emergence of digital tools including dynamic geometry software like (GeoGebra), computer algebra systems (MATLAB), and game-based learning applications (Suh & Moyer, 2007). According to research, by making abstract ideas more concrete and approachable, technology-enhanced learning settings might raise students' motivation and conceptual understanding (Sedig, 2008). In response, technology has been incorporated into mathematics education to provide dynamic, student-cantered learning environments. Online learning platforms, virtual manipulatives, and game-based learning systems provide alternate techniques for increasing student engagement and comprehension

“Digital learning is one of the important key factors in education, especially mathematics. The concept of digital learning is accepted at almost every level of education.” (Mulgena & Marbán 2020; Viberg et al.,2020) especially during pandemic (Engelbrecht et al., 2023). “Nowadays, many countries now incorporate technology into their educational system, which has been demonstrated to improve student performance.’’ (Huda et al., 2024; Vázquez-Cano et al., 2020). Karageorgou (2022) also highlights the importance of enhancing digital competencies of education 4.0. among educators. As a result, teachers must be adaptable to the shift from traditional classroom instruction to digital learning. In this era, the use of technology in mathematics instruction has become more significant. According to Higgins et al. (2017), digital tools provide a wide range of opportunities to improve teaching and learning, from interactive simulations and visualizations to online collaboration platforms and data-driven assessments. The integration of technology in mathematics classroom is now consider as a worldwide necessity to boost student learning and engagement (Abas & David, 2019).

Technology and Mathematics

The embedding and introduction of classroom teaching technologies rely on the growth of teachers' teaching competence in informatization. Teachers' teaching capacity in informatization is a systematic and long-term development process. Teachers and students ought to participate in interactive, problem-solving interactions with technology during the teaching of technology-embedded courses. The conventional teacher-student interaction in modern education has evolved from a human-to-human relationship to a "human-technology" one owing to the role of numerous technologies. Information technology has transformed the teacher-student interaction into a "functional relationship." The implementation of the teaching subject's ideals is hindered by the shortage of real interactions between instructors and students in the technology-controlled process. Therefore, fostering a classroom environment for teacher-student interaction should be the main goal of integrating technology into classroom learning. Teachers faces difficulty to integrate effective technology, and to integrate technology a teacher must have technological and pedagogical expertise (Hartsell et al.,2010), without this expertise a teacher cannot engage class effectively. It has many benefits to teach with technology-embedded learning in classroom. According to Bransford et al., 2000. ,It is become vital portion of our organizations these days (Apenati,2014). ICT has been used in schools since the 1980s, and some schools believe it will play a crucial role in educating future generations It is a modern concept in math education. ICT in mathematics education refers to the use of technology to teach and learn mathematics. Lefebvre et al. (2006) define integration as the use of ICT resources, devices, and tools to improve classroom teaching and learning and enhance students' math teaching. It can promote universal access to education, equity, quality education, teacher and management development, governance, and effective education administration. Integrating ICTs into schools is crucial for increasing teaching and learning quality, considering their significance in society and the future of mathematical education. Balanskat et al. (2006), teachers value the significance of ICTs in education but face challenges in integrating them into their teaching and learning practices. Some researcher said in their study it is challengeable to technology-embedded instructions in the traditional classroom. Some schools have not access to internet, ICT lab, lack of infrastructure, Lack of digital knowledge among teachers these are the hurdles faced by teachers. Apart from this many studies also suggested that the use and integrate

of ICT is somehow depends on teachers' perceptions. Gebremedhin and Fenta (2015) said in their study there is a noteworthy relationship found between the perceptions of teachers towards the practice of ICT in teaching-learning process. Additionally, teachers have diverse perspective to use ICT in education." Even teachers' outlooks considered as critical to the success or failure of ICT incorporation in education." (Apeanti, 2014). Gebremedhin and Fenta (2015) found in their study about teachers' perception of using ICT during class. The report suggested that teacher faces challenges to incorporate ICT into the teaching-learning process. Based on the survey, instructors were hindered because they lacked ICT learning and teaching tools. The data reveal that most college instructors have yet to incorporate ICT into their curriculum planning. By Mac Callum and Jeffrey (2014), assessing teachers' attitudes and views about the adoption of technology. The need to equip teachers with ICT training has been corroborated by the research findings of Hlasna et al. (2017), who indicated that primary school teachers when applying ICT in the classroom need adequate training, and they asserted that the training would result in improved teaching output through the effective application of ICT.Upon the basis of the findings, Hlasna et al. (2017) concluded that educators who have undergone methodological training to use ICT in the classroom are ready to employ it, whereas those without methodological training are reluctant to use it. Based on Ghavifekr et al. (2016), instructors are faced with serious issues like limited access and poor network connectivity, limited technology, fewer resources, fewer time slots, and teacher incompetence. Due to these challenges instructors failed to integrate ICT in classroom instruction, consequently somehow it affects students' performance. Without technology-embedded in mathematics, it is not possible to teach all chapters in traditional way. Nowadays, it is essential to use technology to teach any students whether primary, secondary or higher secondary levels. In mathematics there are many topics which require the utilization of embedded technology like 3D, coordinate geometry, Mensuration etc. so that students can grasp the concept and develop their abstract thinking for solving mathematical problems.

Technology – Embedded Teaching- Meaning and Its importance

Technology embedded classroom provide interactive white board, mathematical software and apps, it enhances visualization, gives immediate feedback, different learning styles, collaboration and communication. Digital tools make classroom learning interactive, which can enrichment learners' engagement and inspiration during class. Technology-embedded classroom provide different learning style simultaneously for diverse learner, interactive allow teacher to demonstrate mathematical problems and solutions. Moreover, students can learn any topic from own pace anytime. Technology-embedded learning is the utilization of digital tools, software, and online platforms to facilitate mathematics education, problem-solving and conceptual understanding. (Li&Ma,2010). Classroom teaching in the information age has great reliance on students as the object of study, the process of learning as the vehicle, and the development of students' abilities as the driving force. It is a two-way process where both teachers and students use all the available teaching tools. But since technology is self-organizing, it re-created the original classroom teaching framework when it came into the classroom. Various models of course instruction under technical assistance have been developed over the last few years as a consequence of varying teachers' visions on technology-embedded teaching included – "technology-assisted teaching, technology integrated teaching and technology-based teaching." Wei (2020),

Types of Technology-embedded used in Teaching

1. **Technology-Assisted Course Teaching**: It is based on teacher centred technology -assisted teaching and student-centred technology-assisted teaching. Teacher centred technology-assisted teaching, which maintains that students, curriculum, instructional technology etc. are all objects in the classroom and that teaching is still teacher-cantered. Students' subjectivity is not valued in this perspective of teachers using a range of technologies to satisfy their diverse requirements; the only thing that has changed is the method the educational material is delivered The second approach is student-cantered technology-assisted instruction, which emphasizes the importance of bringing students at the center of classroom activities. According to Wei (2019), instruction is significant only when students can activate their own motivation and initiative. This technique makes use of information-based teaching platforms and focuses on students' involvement in and creation of knowledge.

2. **Technology-integrated teaching:** it refers to that type of teaching in which teachers, learners and technology embedded device are interact and influence each other in a classroom setting. Leading-subject technology integrated teaching and interactive-subject technology integrated teaching are the two types of technology-integrated teaching. Where according to leading-subject technology integrated teaching, teacher is considered to be supreme in leading role during the classroom teaching process and uses a different type of technological embedded devices and tools to influence the students and interactive-subject technology integrated teaching is the type of teaching which, selecting a subject for the classroom should not be a choice between teachers and students, as doing so would undermine one's position. Effective classroom education involves equitable interaction between teachers and students, utilizing diverse technologies. (Shi,Z.Y,2007).
3. **Technology-Based Classroom Teaching:** In a technology-based course, the setting and materials for classroom instruction are provided by the technology, and students and teachers communicate while learning. "Utilizing technology to teach in the classroom is demonstrated via a paradigm that emphasizes the use of information-based teaching materials and environments." Wei (2019). It maintains that instruction in the classroom takes place in a specific setting with specific resources; first of all, t is vital to establish a new teaching environment based on the needs of learners and learners are pushed to be involve in teaching learning or encourage to be interact with teachers. Secondly, teachers should act as mentors, assistants, and supervisors during the instructional process for ensuring that students' initiative is optimally utilized.

Importance of technology-embedded tools for mathematics learning

Technology-embedded tools play an important role in improving mathematics education by making concepts more interactive, engaging, and accessible. It helps student to grasp the abstract concept of mathematics. Technology- embedded tools helps students to learn specific topic. By using these tools students may solve one problem in various methods. It has ability to improve conceptual understanding, promote active learning and make students active.

Nowadays, when it is the era of digital learning, it is essential to teach every subject by using technological device or tools, doing so not only increases student involvement but also foster a deeper understanding of concepts. with the use of traditional method, one cannot keep students engage or motivated because they can easily lose interest in the presence of mobile and digital devices. In mathematics, many topics are difficult to teach effectively without the use of ICT tools. Technology has changed how mathematics is taught and learned. Traditional methods of instruction, while effective in some cases, frequently fail to interest all students or deliver tailored learning experiences. The incorporation of technologically advanced tools into mathematics education has transformed learning by making abstract topics more accessible, interactive, and engaging. These tools include graphing calculators, interactive simulations, tutoring systems powered by artificial intelligence (AI), and computer-based examinations. These technologies are important for more than just engagement; they boost conceptual knowledge, problem-solving skills, and meet a wide range of learning needs. According to Obara et al. (2018), technology allows teachers to use dynamic presentations, interactive simulations, and virtual manipulatives instead of traditional lecture-based instruction. Technology can automate processes like as grading, tracking, and preparing assessments (Abas & David, 2019), allowing teachers to focus on tailored education and student interaction. Young (2017) found that technology enables teachers to collect and analyze student data, detect learning gaps, measure progress, and personalize instruction. Technology enhances the interaction of students, leading to improved learning. BECTA (2003) unveiled that technology facilitates students in presenting their results and engaging in discussions on various subjects. A key aspect is that technology enhanced student interaction even in the absence of teacher guidance.. One of the most significant lessons that educators want to instill in their pupils is the effective use of teamwork to solve challenges, as collaboration is essential in most professional situations.

Ict integrated classroom help in many ways, like

Interactive Tools: "Technology has enabled more interactive mathematics learning". (Lai, Headage, & Knezek, 2013). Through the use of virtual manipulatives, graphing calculators, and geometry software, students can visualize and manipulate mathematical objects, bringing abstract concepts to life. By using these

tools, students are better able to understand mathematical concepts through inquiry and exploration.

Real-world Application: Technology bridges the gap between theoretical and practical mathematical notions. Interactive simulations and modelling tools can help students apply mathematical concepts to real-world settings, highlighting the significance of math in various professions. Incorporating students into real-life situations and data sets enhances their mathematical learning and development. The strategy goes beyond the traditional lessons and text-based examples to enable learners to use mathematical concepts to solve real-life problems and grasp their applicability.

Enhance engagement and motivation: One of the main advantages of technology is one of the most significant benefits of technology in mathematics education is its capacity to make learning more engaging and participatory. Interactive tools like gamified learning platforms and simulation-based learning considerably increase student motivation (Cheung & Slavin, 2013). GeoGebra, Desmos, and Wolfram Alpha are examples of digital tools that provide dynamic visual representations and allow students to intuitively explore mathematical concepts.

Personalized and Adaptive Learning: By embedded technology in mathematics education, it helps learners to personalized ad adaptive learning. Each student has individual learning styles, abilities and interest. ICT tools and integrated technology helps students to use personalize and adaptive learning. With personalized adaptive learning each student. With personalized adaptive learning, each student feels supported and valued, every learner gets a chance to achieve grade-level proficiency. iPrep PAL, is one of the personalized adaptive learning apps which help students to view solution Adaptive learning systems offer students a personalized learning environment. As stated in the 2017 Horizon Report by Adams Becker, Cummins, Davis, Freeman, Hall, and Ananthanarayanan, "adaptive learning technologies are among the six most impactful educational innovations for higher education institutions."

Challenges to integrate ICT in mathematics: The ultimate purpose of using technology into classroom instruction should be to promote students' holistic development, as seen by their knowledge acquisition and skill migration. Still, technology-inserted course assessment is still utilitarian and addresses only outcomes assessment, which can hinder students' overall development. Technology-empowered course assessment ought to satisfy society's, schools', teachers', students', and other subjects' interests through a pluralistic perspective. It should not prioritize one component over others and allow for dynamic evaluation criteria. Second, technology-embedded course evaluation ought to emphasize student development by modifying evaluation criteria to their gender, personality, and abilities. It should also use numerous technical means to meet students' diverse learning needs, ensuring wide-ranging development (Zhao & Guo, 2010). However, according to Liu, Z. and Yin, R. (2014), Under the impact of many technologies, contemporary teaching redefines classroom instruction as a process of skill migration and knowledge transfer that is characterized by technological control, and overlooks the interaction between students and teachers in class. Additionally, while using modern technology in the classroom might create a barrier among teachers and students, restricting their original teaching style and reducing interest for involvement.

Teacher Training and Pedagogical shifts: To effectively integration of technology into mathematics instruction requires teacher to be adequately trained in digital pedagogy (Ertmer & Ottenbreit -Leftwich, 2013). Many instructors struggle with using technology due to outdated knowledge or lack of digital literacy. Teachers to be trained through professional development program so that they used digital tools for deeper understanding.

Lack of infrastructure: Many teachers are eager to utilize technology for enhancing students' problem-solving skills, but they failed to do so due to missing smart classroom, ICT labs or insufficient computers. Most of the school do not have access to inadequate power supply for using technology. Additionally, outdated equipment, insufficient software, lack of proper furniture also hinders the classroom teaching-learning environment.

Lack of technical support: Many schools do no have good technical support due to this teacher failed to integrate ICT in mathematics classroom. Pelgrum (2001) told in his research, teachers belong to primary or

secondary school from their point of view major barriers to use ICT in classrooms is very low technical support. Open a document from internet, failing to connect to the network are some technical errors which might be happen during classroom. By Sicilia's (2005), technical problems are considered to be major barriers for teachers**.**

Digital Divide and Accessibility: "All students do not have equal access to technology, resulting in a digital divide that may exacerbate educational disparities." (Van Dijk, 2020). "Limited access to devices, internet connectivity, and digital literacy skills are significant barriers, especially in low-income communities and developing countries." (Selwyn, 2016).

CONCLUSION

The integration of embedded technology in mathematics education has significantly transformed modern teaching practices. Technology-enhanced classrooms help students understand, think critically, and solve problems by making learning more interactive and interesting. Various technology-assisted approaches, such as technology-integrated and technology-based teaching, provide flexibility and efficiency in instruction. Technology use in math education holds great promise to revolutionize the learning process and enhance student achievement. Through interactive tools, teaching software, and internet-based learning environments, teachers are able to design customized learning environments that respond to the prerequisites of a diverse range of students. ICT is a crucial tool for helping children learn mathematics. However, challenges such as, including inadequate infrastructure, lack of integration in curriculum, training and support, digital divide and accessibility and lack of network connectivity high costs, accessibility issues, and lack of digital literacy hinder seamless implementation. Despite these challenges, the benefits of technology in mathematics learning outweigh the drawbacks. To fully utilize its potential, educators must find effective solutions to integrate technology into regular classrooms, ensuring an inclusive and efficient learning environment for all students. Bridging the digital divide and giving teachers appropriate support and training is of critical importance. By using technology in a careful and assessed manner, children are able to gain a deep understanding of mathematics, improve critical thinking skills, and be better prepared for accomplishment in a digital world. We are able to utilize technology to make mathematics more accessible, exciting, and useful to all learners. Successful ways for overcoming these obstacles include professional development, curriculum integration, and balanced access to materials. Educators may create effective, dynamic, and individualized learning environments that meet the necessities of a diverse student population by using technology thoughtfully and inclusively. Ultimately, technology-embedded learning in mathematics can bridge learning gaps and prepare students to do well in an progressively digital world.

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