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Practical Technology Integration into Mathematics Teaching in Elementary Education: Instructional Design Model, Teaching Strategies, and Assessment Techniques

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Abstract

In the field of elementary education, integrating technology into mathematics teaching has gained significant attention due to its potential benefits in enhancing student engagement and understanding. As an educator, technology practitioner, and mathematics instructor, it because a fact that elementary students cannot gain efficiently the intended learning outcomes by teaching mathematics away from technology. This study aims to explore the advantages of integrating technology into mathematics education and to discuss the challenges and considerations involved in this process. It describes instructional design model for effective integration and provides examples of practical integration at the elementary education using strategies for successful implementation. It explores assessment methods aligned with instructional goals and highlights implications for teacher professional development. It discusses, suggests, and emphasizes the significance of incorporating technology as a tool to enhance students' mathematical learning experience. Mathematics curriculum of grade 5 in Bahrain public schools was incorporated in the integration.

Keywords: *technology integration, mathematics teaching, elementary education, instructional design model*

Introduction

Technology has emerged as an innovative tool in the field of education, offering unique opportunities to enhance learning experiences across various disciplines. In today's digital age, technology has become an integral part of our daily lives. Its impact on various sectors, including education, is undeniable (Abdillah et al., 2022). In elementary education, the integration of technology holds immense potential for enhancing teaching and learning experiences across different subjects, including mathematics. One such area where technology shows great promise is in teaching mathematics (Sasota et al., 2021). Mathematics education plays a vital role in developing critical thinking skills and logical reasoning abilities among students. However, many students struggle with comprehending abstract mathematical concepts due to their inherent complexity and lack of practical application. By incorporating technology into mathematics instruction, educators can create immersive and interactive environments that facilitate

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conceptual understanding and engage students in meaningful learning experiences (Anita et al., 2021).

Before delving into the practical examples of how technology can be utilized in teaching mathematics, it is essential to define the concept itself. In the context of teaching mathematics, technology integration refers to the purposeful incorporation of technological tools and resources into math lessons to support student learning and understanding (Zhang, 2022). These tools can include interactive online platforms, educational apps, virtual manipulatives, graphing calculators, simulations, and augmented reality applications. Effective technology integration involves using these tools as pedagogical aids rather than mere substitutes for traditional instructional methods (Haris, 2022). When used appropriately and strategically by teachers who have a deep understanding of both content knowledge (mathematics) and pedagogical knowledge (effective teaching practices), technology can enhance math instruction by providing opportunities for active engagement, conceptual development, problem-solving skills acquisition, and real-world connections (Young, M., 2017).

Despite these benefits, there are challenges associated with integrating technology into mathematics education that educators must address. One significant challenge is ensuring access to reliable technological resources. Not all schools or classrooms may have access to the necessary infrastructure, devices, or software required for effective integration (Clemence-Mkhope et al., 2019).

This lack of access can create disparities among students and hinder the potential benefits of technology integration. Another challenge involves selecting appropriate technological tools and resources that align with instructional goals. With an abundance of digital resources available, educators must carefully evaluate their appropriateness in supporting specific mathematical concepts and skills. Additionally, considering factors such as cost-effectiveness, ease of use, and compatibility with existing curriculum frameworks is crucial to ensure efficient integration (Anita et al., 2021).

The purpose of this study is to explore the advantages of integrating technology into mathematics education and to discuss the challenges and considerations involved in this process. It describes instructional design stages for effective integration and provides examples of practical integration at the elementary level using strategies for successful implementation.

It explores assessment methods aligned with instructional goals and highlights implications for teacher professional development. It discusses, suggests, and emphasizes the significance of incorporating technology as a tool to enhance students' mathematical learning experience. Mathematics curriculum of 5th grade in Bahrain public schools was incorporated in the integration.

Literature Review

Perspectives of Technology Integration

Technology integration in teaching mathematics has become increasingly important in contemporary education. With the rapid advancements in technology, educators recognize its potential to enhance students' learning experiences and improve their mathematical skills (Abdillah et al., 2022). Technology integration refers to a computer-generated support of a multi-dimensional environment that users can explore and interact with through sensory stimuli (Xie et al., 2022).

In educational settings, technology integration is seen as it allows students to immerse themselves in realistic scenarios or manipulate virtual objects, providing a hands-on approach to learning difficult concepts. Technology integration refers to the purposeful incorporation of technological tools and resources into instructional practices to enhance student learning outcomes (Firat, 2020). Technology integration refers to the incorporation of various technological tools and resources into instructional practices to support teaching and learning processes (Karma et al., 2019).

In the context of elementary mathematics education, it involves utilizing various technological tools such as educational apps, interactive whiteboards, online resources, and adaptive technologies to support mathematical understanding and problem-solving skills (Zhang, 2022). In mathematics education, technology integration plays a crucial role in promoting student-centered learning, problem-solving skills, and critical thinking abilities (Chinangure & Mapaire, 2017).

Technology Potentials in Teaching Mathematics

Technology has become an integral part of our daily lives, transforming various aspects of society, including education. In the field of mathematics education, integrating technology into instructional designs has gained significant attention due to its potential to enhance students' learning and engagement. The importance of teaching mathematics cannot be overstated. Mathematics serves as the foundation for numerous fields such as science, technology, engineering, and economics (Chatain et al., 2022). Proficiency in math equips individuals with problem-solving skills necessary for real-world applications. However, many students struggle with math due to its abstract nature and lack of concrete connections to everyday life.

There are several advantages associated with integrating technology into math lessons at the elementary level. Integrating technology into mathematics education offers numerous benefits that can positively impact students' learning outcomes. Firstly and foremost is the increased engagement it offers. Research shows that incorporating technology fosters student engagement

as it taps into their familiarity with digital devices and promotes a dynamic learning environment where they can actively interact with mathematical concepts (Young, M., 2017).

By utilizing technological tools such as interactive whiteboards or virtual manipulatives, teachers can create dynamic and interactive lessons that capture students' attention and foster active participation (Çağlar et al., 2017). This heightened engagement can lead to greater motivation and enthusiasm among students towards learning mathematics. It provides opportunities for students to engage with mathematical concepts through interactive activities that promote active participation and exploration (Sasota et al., 2021). Technology provides an immersive experience that captures student attention by creating realistic simulations or scenarios related to mathematical concepts (Zhang, 2022). This enhanced engagement helps overcome apathy towards math and fosters active participation in the learning process.

Moreover, integrating technology in mathematics instruction enables students to develop a deeper conceptual understanding of mathematical concepts. For example, using educational software or online simulations allows students to visualize abstract ideas and engage in hands-on exploration (Haris, 2022). Educational apps designed specifically for math can offer engaging content with visual representations and gamified elements that make learning enjoyable while reinforcing important mathematical concepts. Additionally, technology allows for individualized instruction where each student's strengths and weaknesses can be targeted, and challenging math concepts can be made accessible through visual explanations and support tools (Othman, N., & Maat, S. M., 2020). These visualizations help make complex mathematical concepts more accessible by providing concrete representations that facilitate comprehension. According to Mohd Rasid et al. (2020), technology can provide interactive tools and resources that promote active learning experiences and stimulate critical thinking skills. By using technological tools such as educational apps or online simulations, students can visualize complex mathematical concepts, solve problems collaboratively, and develop a deeper understanding of mathematical principles. Furthermore, the use of technology in math instruction encourages students' collaboration and communication skills as well as improves critical thinking and problem solving abilities (Young, M., 2017).

Furthermore, technology can support personalized learning experiences tailored to individual student needs. Adaptive technologies offer customized content delivery based on students' strengths and weaknesses (Anita et al., 2021). Through these personalized approaches, students can receive targeted support or extension activities according to their specific learning profiles. This differentiation promotes inclusivity by accommodating diverse abilities within one classroom setting. Through adaptive technologies or intelligent tutoring systems, students can receive immediate feedback based on their responses or progress levels. This personalized approach fosters a deeper understanding of mathematical concepts by addressing individual

strengths and weaknesses (Abdillah et al., 2022). Moreover, integrating technology into math lessons provides an opportunity for personalized learning as students can work at their own pace and receive immediate feedback on their progress (Young, M., 2017).

Technology Challenges in Teaching Mathematics

While the integration of technology offers numerous benefits, there are also potential challenges that teachers may face when implementing it into elementary math classrooms. One common challenge is a lack of access to necessary technological resources (Sasota et al., 2021). Not all schools have equal access to devices like tablets or computers, hindering widespread implementation of technology-enhanced mathematics education (Othman, N., & Maat, S. M., 2020). Another consideration is the need for professional development opportunities for teachers to enhance their pedagogical practices involving technology integration. Teachers must receive adequate training on how to effectively use technological tools and align them with instructional goals and curriculum standards. Ongoing support from administrators and collaboration among educators can help overcome these challenges and ensure successful implementation (Sasota et al., 2021).

One significant challenge is the cost involved in acquiring high-quality technology equipment and software (Caussarieu et al., 2022). Additionally, accessibility issues may arise due to unequal access to technology among schools or individuals from disadvantaged backgrounds. Technical glitches or compatibility issues can also hinder seamless integration of technology into instructional practices (Chatain et al., 2022).

One of the main concerns is access to reliable technology and internet connectivity for all students. Socioeconomic disparities can hinder equitable access to digital resources, limiting some students' opportunities for learning (Clemence-Mkhope et al., 2019). Insufficient training or lack of expertise among teachers can also pose a challenge as they may feel overwhelmed or unsure about how best to integrate technology effectively (Young, M., 2017).

Moreover, using technology in math instruction requires careful planning and implementation to ensure that it aligns with the curriculum goals and does not become a mere distraction for students. Additionally, some critics argue that an over-reliance on technology may hinder students' development of core mathematical skills such as mental calculations or handwriting (Anita et al., 2021).

Additionally, teachers may face a learning curve when adopting new technologies or instructional designs (Iringan, 2020). Professional development and ongoing support from administrators are crucial in overcoming these challenges and ensuring successful implementation of technology-integrated mathematics instruction (Xie et al., 2022).

Conceptual Framework of Integrated Technology and Mathematics

Many studies have discussed the potential instructional designs, teaching strategies, and assessment techniques to be applied when integrating technology in teaching mathematics. There were some common elements that were used to describe these three crucial dimensions. However, there were some studies that presented some unique elements in this regards.

One study conducted by Niem et al. (2020) examined the ramifications of ICT integration in mathematics education. The study followed the instructional design ADDIE model, including: analysis, design, development, implementation, and evaluation. It focused on some specific teaching strategies, like: interactive whiteboards, educational applications, virtual manipulatives, and interactive software. It assessed the learning outcomes using: online quizzes and digital assessments. The researchers found that incorporating technology tools such as virtual manipulatives and interactive software positively influenced students' engagement, motivation, understanding, problem-solving abilities, and conceptual development in mathematics. However, this study also highlighted some limitations such as resource constraints and varying levels of technological proficiency among teachers.

Ku et al. (2022) conducted a study to investigate and explore various aspects such as STEM integration behavior among middle school students. They applied the SAM instructional design model, including: start gathering background, approximate, refine, and implement. They suggested some teaching strategies, such as: online guided class discussion, Google Forms, Kahoot, Class Dojo, and digital tools. They use gamification and interactive simulation as assessment techniques. The study found that integrating technology in teaching mathematics, science, and engineering increased students' engagement, creativity, and critical thinking skills. However, students consumed more time while working on the data analysis using technology than other learning activities.

Bwalya and Rutegwa (2023) conducted a study to examine the technological pedagogical content knowledge self-efficacy of pre-service science and mathematics teachers as a comparative study between two Zambian universities. They included Bloom's Taxonomy as an instructional design consisted of five stages, including: understand, apply, analyze, evaluate, and create. This study discussed some teaching strategies, like: online resources, digital scaffolding, technical assistance, and technology-mediated group work. They shed the light on some technology assessment techniques, such as: digital projects, social media discussion, and virtual laps. It found that students increased their content knowledge self-efficacy by using technology to learn mathematics. However, it mentioned that technology tools are not always available to students in a high quality and that may impact the goal achievement.

Young (2017) investigated the quality of literature review and discussion of findings in selected papers on ICT integration in teaching mathematics, including: instructional designs, teaching strategies, and assessment techniques. The author discovered that many studies lacked a comprehensive review of existing literature, incomplete discussion and presentation of conceptual framework, inconsistent connection between the instructional design, teaching strategies, and assessment techniques, or failed to critically analyze their findings effectively.

Consequently, this study covers the aforementioned elements by suggesting a cohesive and solid conceptual framework, including: instructional design stages, teaching strategies, and assessment techniques.

Problem Statement and Study Questions

It is important to any teacher to involve in teaching new courses and discover new instructional designs, use new teaching strategies, and apply different assessment techniques, in order to increase teacher's professional development. Teachers who involved in such professional development activities, developed better attitude towards their work and enriched their content and pedagogical knowledge and skills (Rahman & Setyaningrum, 2022). As common aspects, many studies mentioned to the positive impact of integrating technology into teaching mathematics, in increasing: achievement, motivation, engagement, critical skills, creativity, self-efficacy, collaboration, and communicate skills (Othman & Maat, 2020).

On the other hand, the curricula that deal with subjects separately and disconnecting topics, cannot provide students with the highly needed 21st century skills that are important for students to live successfully in future. It is crucial to equip students with integrated subjects, like: technology and mathematics to provide them with reasonable learning opportunities (Roberts & Kruse, 2023).

The integration between different majors in education, such as: technology and mathematics provides many advantages in terms of enabling students to achieve the learning outcomes and improving students' learning mastery. This integration can develop their skills that they need in current time and future careers. Also, teachers are required to adopt many instructional designs and develop their teaching strategies by applying new teaching activities to be able to assess students' learning effectively (Lahdenperä et al., 2018).

Based on the previous explanation and presented conceptual frameworks and findings of the previous studies, there is a crucial demand and significant need to propose and apply more consistent and practical conceptual framework of integrated technology and mathematics. It is obvious that there is a lack in analyzing the instructional design stages.

According to the relevant studies revisions, it is velar that there is a wide gap in between the available integrated frameworks and the used teaching strategies. Namely, there is a numerous of the analyzed studies neglected the assessment techniques with no explanation nor discussion. It is important to provide the reader a clear assessment guidance of integrating technology into mathematics.

Hence, this study has the potential overcome the aforementioned limitations and to be helpful in maximizing the implementation of interdisciplinary teaching and learning activities between technology and mathematics by suggesting a unique instructional design incorporated with the suitable teaching strategies and assessment techniques.

Therefore, this study aims to provide answers of the following study questions:

1. What are the instructional design stages of technology integration into teaching mathematics?
2. What are the most suitable teaching strategies of mathematics in integration with technology?
3. What are the best techniques of assessing learning mathematics with the technology integration?

Methodology

Context of the Integrated Technology into the Mathematics Unit

In the Kingdome of Bahrain, all students are involved in the mandatory education system The educational system, including: elementary and preparatory education. The elementary education consists of 6 years from grade 1 to grade 6, in which students age are ranged from 6 years to 12 years old in general. In grade 3, the ideal age is ranged between 8 to 9 years old.

However, the preparatory education consists of 3 years from grade preparatory 1 to 3, in which their ages are ranged between 13 to 15 years old. Namely, the educational system in Bahrain provides students with the equal learning opportunity to learn the essential knowledge and skills, especially, in mathematics and technology.

There are 2 types of schools in Bahrain, public and private schools and both are under the professional supervision of the Ministry of Education in Bahrain. There are around 150,000 students are enrolled and studying in the public schools for free of charge and receiving high quality of education and learning opportunities.

In addition to that, there are approximately 80,000 students are enrolled and studying in private schools for a certain amount of fees that differs between private schools. A careful review of the

aforementioned statistical data, it reveals that the ratio of students enrolled in public and private schools is (2:1), meaning that approximately 65% of students in Bahrain are studying in public schools.

This study focuses on integrating technology into a mathematics unit in grade 5 in public schools in Bahrain. It suggests a cohesive frame work of instructional design, teaching strategies, and assessment techniques that the researcher is professional in terms of majors and experience. Therefore, this study does not involve students during preparing the integration framework, because it provides the readers with a well-prepared instructional design, teaching strategies, and assessment techniques. This proposed framework has high potentials when it is used for teaching students in schools by teachers, practitioners, and researchers. Undoubtedly, the results of using this framework may not be the same when used by different teachers and different students groups.

This variation in results can be caused by the differences among teachers' abilities and skills, and students' different characteristics. The public schools curriculum of mathematics in grade 5 was used in this study. This mathematics curriculum of grade 5 was selected due to its nature and the types of topics that have flexibility in integrating with technology, including: topics, knowledge, concepts, and skills.

To have a deeper view on the integrated mathematics topics, this study focus on 4 algebraic topics, including: algebraic expressions, solving linear equations, integers numbers set, and chart graphing. Currently, students in grade 5 study 6 periods of mathematics every week. This integration framework is suggested for 6 periods per week throughout 2 weeks.

This suggested framework of integrating technology and mathematics guides teachers and students to go through 5 stages of a suggested instructional design model using 5 teaching strategies followed by 5 assessment techniques.

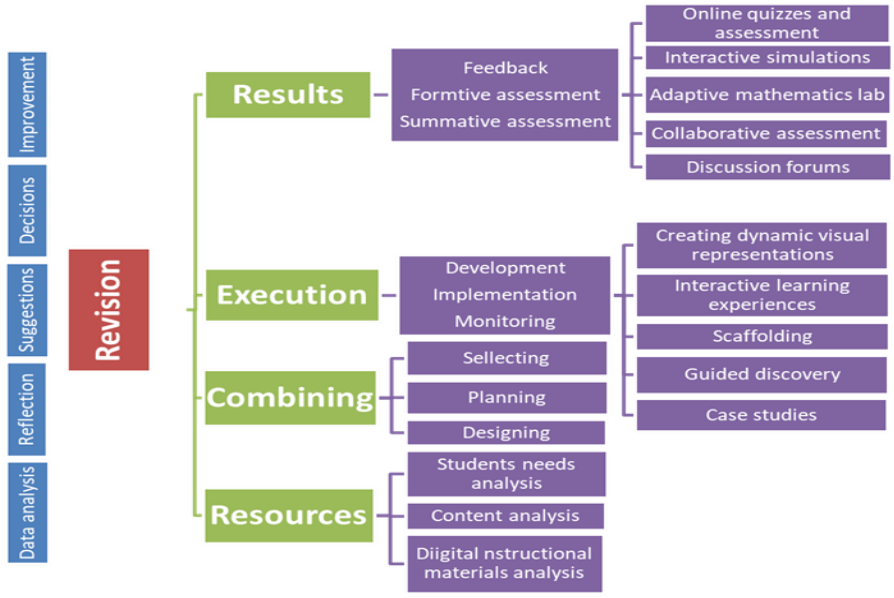
Instructional Design Model (RCERR) of Integrating Technology into Teaching Mathematics

In today's digital era, it is crucial for educators to embrace technology as a tool for enhancing teaching and learning experiences. Through the systematic application of instructional designing stages, teachers can successfully integrate technology into mathematics instruction and create meaningful educational opportunities that prepare students for a technologically advanced future.

This study proposes an instructional design model (RCERR) consist of 5 stages, including: resources, combining, execution, results, and revision, as shown in Figure 1. It shows a circular design of the suggested integrated framework connecting all stages together. Each stage has a

role to be done and needs a series of steps based on the reviewed theoretical and practical backgrounds.

FIGURE 1: Suggested Instructional Design Model (RCERR) of Technology and Mathematics Integration.



Resource Collection stage enables teachers to analyze their students' needs and goals for integrating technology in mathematics instruction. By understanding specific areas where technology can enhance student learning experiences or address skill gaps (Tokanov et al., 2023), teachers can make informed decisions about which technologies to incorporate and how they can support student achievement. At this stage also, teachers determine what technologies are most appropriate based on identified needs. Digital tools, software, and other instructional materials are identified in this stage. They also establish clear objectives for student learning outcomes by considering both content knowledge and technological skills development (Sasota et al., 2021). Effective planning ensures that the integration of technology supports mathematical concepts while promoting active engagement among students (Othman & Maat, 2020).

Combining stage focuses on content selection and curriculum alignment. Here, teachers carefully choose digital resources that align with the existing mathematics curriculum standards. The selected resources should complement and enhance the teaching of mathematical concepts, providing students with interactive and hands-on learning opportunities (Mohd Rasid et al., 2020). It involves developing effective teaching strategies using technology tools to engage students in meaningful mathematical tasks. Teachers design lessons that leverage interactive tools

or multimedia resources to deepen conceptual understanding, promote critical thinking, and foster collaborative problem-solving. This stage ensures that technology integration is purposeful and supports the intended learning outcomes. Teachers choose the most suitable teaching strategies that fit to the mathematics topics in integration with technology.

Execution stage is crucial because instructional strategies and lesson design are taken place and implemented at this stage of instructional designing. Once lessons are designed and materials are prepared, it is time for implementation. In this stage, teachers implement planned lessons using technology tools while monitoring student progress (Akram et al., 2022). Teachers apply the planned teaching strategies and classrooms activities accompanied with technological sources and instructional materials in light of the intended learning outcomes and objectives in mathematics.

Results measurement stage is important due to the fact that technology allows for real-time feedback through digital assessments, enabling teachers to provide timely interventions or modifications to their instruction based on individual needs (Tokanov et al., 2023). Teachers apply the planned assessment techniques by ensuring the formative and summative assessments to measure the level of intended learning outcomes accomplishment achieved by the students. Assessment data collected through technological resources inform teachers about student performance and help guide future instruction.

Revision stage is a space for data analysis, reflection, and evaluation that form this stage of instructional designing. Teachers analyze student performance data gathered during assessment to evaluate the effectiveness of their instructional practices (Sasota et al., 2021). Revision plays a crucial role in identifying areas for improvement and making recommendations, suggestions, and informed decisions about future instruction. By revision on both student outcomes and their own pedagogical approaches, educators can continuously refine their use of technology in mathematics instruction (Roberts & Kruse, 2023).

Teaching Strategies of Mathematics in Integration with Technology

Mathematics can be taught using hundreds if not thousands of teaching strategies that are helpful for students learning of mathematics topics. However, there are specific teaching strategies that work better for teaching mathematics with integrated technology. Also, there are some mathematics teaching strategies that fit to a specific instructional design better than others. This selectivity of teaching strategy is due to the fact that mathematics teaching strategies are different in terms of the intended topic and required teaching stages.

Therefore, this study suggests 5 teaching strategies to be applied into teaching mathematics in integration with technology, including: creating dynamic visual representations, interactive learning experiences, scaffolding, guided discovery, and case studies. Specifically, these teaching

strategies are selected for the targeted topics that are perfectly compatible with the suggested instructional design model and assessment techniques.

Creating dynamic visual representations strategy using interactive digital whiteboards or smart boards and SMART Notebook software enable teachers to create dynamic visual representations of mathematical concepts (Chinangure & Mapaire, 2017). For example, teachers can use these boards to demonstrate geometric constructions or solve algebraic equations. Students can actively participate by manipulating digital objects on the board (Mutende, 2015). Interactive learning experiences strategy using educational apps and online resources provide interactive learning experiences that cater to individual student needs (Karma et al., 2019). For instance, Khan Academy and Math Playground interactive lab offer a wide range of math tutorials and practice exercises at various difficulty levels. Similarly, Math Playground provides engaging games that reinforce mathematical skills.

Guided discovery strategy using the virtual manipulatives allow students to explore mathematical concepts through hands-on experimentation (Hossein-Mohand et al., 2021). GeoGebra is an example of a virtual manipulative tool that enables students to create geometric figures or explore functions graphically. These tools promote conceptual understanding by providing visual representations of abstract ideas. Scaffolding strategy enables teachers to offer support to students who may struggle with learning a certain topic in mathematics in support with technology usage (Mutende, 2015). The teacher can share a new piece of information or skill with students and show them how to solve it using Easy Scaffolding Design website & Common Core ConceptBank App. Gradually, the teacher steps back and allows the students to progress based themselves. The teacher is available to provide instant and little support to scaffold students learning. Case studies strategy enables teachers and students to successfully implement technology integration in mathematics education. Several case studies have demonstrated the positive impact of technology integration in mathematics education. For example, a study by Karma et al. (2019) explored the implementation of blended learning, combining face-to-face instruction with online resources, in an applied mathematics course. The results showed improved student engagement and achievement.

Techniques of Assessing Learning Mathematics with the Technology Integration

Integrating technology into math assessment methods expands opportunities for effective evaluation while promoting critical thinking skills in students (Yusri Wahyuni et al., 2021). The utilization of technology in assessing learning mathematics brings several advantages that traditional paper-and-pencil assessments lack. It enables immediate feedback on students' work allowing them to correct errors promptly (Ky Long Nguyen et al., 2022). This instant feedback helps students identify misconceptions and enables targeted intervention strategies from teachers.

Integrating technology into math assessments provides personalized learning experiences. Adaptive learning systems, for instance, adjust difficulty levels based on individual student needs (Sasota et al., 2021). This personalized approach ensures that students are challenged appropriately and receive tailored support to address their specific areas of weakness. Technology integration in math assessment promotes engagement and motivation among students. Gamification techniques such as game-based assessments make the learning process enjoyable by incorporating elements like rewards, competition, and interactive challenges (Yusri Wahyuni et al., 2021). This gamified approach fosters a positive learning environment where students actively participate in assessments with enthusiasm.

To evaluate the effectiveness of technology integration in teaching mathematics, various specific methods can be employed, including: online quizzes and assessment, interactive simulations, adaptive mathematics lab, collaborative assessment, and discussion forums.

Online quizzes and assessments using online platforms provide a wide range of tools for creating quizzes that assess various mathematical concepts effectively. These platforms offer features such as automatic grading, instant feedback, and data analysis capabilities (Karma et al., 2019). Teachers can design quizzes that cover different topics within mathematics while ensuring prompt feedback is given to students. Gamification techniques can be employed in math assessments using technology to enhance student motivation and engagement. Teachers can create game-based assessments that simulate real-world problem-solving situations or incorporate interactive challenges into the assessment process (Ky Long Nguyen et al., 2022). By transforming assessments into engaging experiences, gamification helps foster a positive attitude towards mathematics among students.

Interactive simulations, like: Wakelet, The Edvocate, and Google Math are valuable tools for assessing mathematical understanding as they allow students to manipulate variables, visualize concepts, and solve problems in a virtual environment (Yusri Wahyuni et al., 2021). Simulations provide an opportunity for students to explore mathematical ideas beyond what is possible with traditional paper-and-pencil tests.

Adaptive mathematics lab systems utilize technology to tailor assessments based on individual student needs. These systems adjust difficulty levels according to each student's proficiency level and progress over time (Sasota et al., 2021). By providing targeted practice and continuous feedback, adaptive mathematics lab systems support assessing students' mathematical growth at their own pace.

Collaborative assessment tools facilitate group work in assessing mathematical understanding. Real-time collaboration features enable students to work together on problem-solving tasks, share insights, and evaluate each other's contributions (Karma et al., 2019). Discussion forums

allow for peer-to-peer interaction, enhancing the learning experience and promoting a deeper understanding of mathematical concepts.

Discussion and Suggestions

The use of technology in mathematics instruction can provide students with engaging learning experiences, help them visualize abstract concepts, and promote problem-solving skills (Mohd Rasid et al., 2020). However, simply incorporating technology into the classroom without a systematic approach may not yield desired results. This is where RCERR instructional designing stages come into play to ensure that technology integration is planned and executed effectively by incorporating well-designed teaching strategies and carefully selected assessment techniques, as appear in Table 1, as it shows the homogeneous combination between these elements in a consistent procedure.

TABLE 1: Suggested teaching strategies and assessment techniques of integrating technology and mathematics

Weeks	Periods	Topics	Learning Outcomes	Teaching Strategies	Assessment Techniques
Week 1	1	Algebraic Expressions	Identify the main elements of algebra, such as: variables, constants, terms, expressions, common factor monomial, like terms, and equations.	Guided discovery via virtual manipulatives by identifying the main elements of algebra, using GeoGebra.	Adaptive mathematics lab, using: Google Math Shelf.
	2	Venn Diagrams	Apply Venn Diagrams to classify and group items according to their properties and characteristic.	Creating dynamic visual representations by applying Venn Diagrams to classify and group items, using: SMART Notebook software.	Interactive simulations, using: Wakelet.
	3	Ratio and Proportion	Interpret proportional reasoning using numerical expressions.	Scaffolding by Interpret proportional reasoning, using: Common Core ConceptBank App.	Online quizzes and assessment, using: Google Forms.
	4	Integers	Conduct calculations consist of integers.	Interactive learning experiences by conducting calculations consist of integers, using: Math	Collaborative assessment, using: MS Teams 365.

				Playground interactive lab.	
	5	Integers	Solve word problems of order of operation on integers.	Case studies by solving word problems on integers, using: Made for Math website.	Discussion forums, using: MathOverFlow.
	6	Graphs and Co-ordinates	Represent data using graph and visual geometrical representations.	Creating dynamic visual representations by Represent data and drawing graphs, using: digital smart boards.	Interactive simulations, using: The Edvocate.
Week 2	7	Graphs and Co-ordinates	Plot the coordinates and interpret graphs using given equations.	Creating dynamic visual representations by Plot the coordinates and interpret graphs, using: digital smart boards & SMART Notebook software.	Collaborative assessment, using: Edutopia.
	8	Ratio and Proportion	Describe life applications using proportional reasoning.	Scaffolding by describing life applications of proportional reasoning, using: Easy Scaffolding Design website.	Online quizzes and assessment, using: Kahoot.
	9	Graphs and Co-ordinates	Use graphs drawings to interpret given data.	Creating dynamic visual representations by interpreting given data using graph drawings, using: Tableau software.	Adaptive mathematics lab, using: AdaptedMind Math.
	10	Ratio and Proportion	Use proportional reasoning to solve real-life problems.	Case studies by solving real-life problems, using: Lastep App.	Collaborative assessment, using: MS Teams 365
	11	Ratio and Proportion	Apply different forms of proportional reasoning into different scenarios.	Interactive learning experiences by dealing with several scenarios and applying different forms of proportional reasoning, using: Math Playground interactive lab.	Interactive simulations, using: Google Math Simulator for Children.
	12	Linear Equations	Balance the given linear equations using	Guided discovery by using appropriate	Discussion forums, using:

	appropriate properties and operations.	properties and operations to balance the given linear equations, using: GeoGebra.		Students of the World.

Indeed, these instructional designing stages are essential for integrating technology into teaching mathematics effectively. These stages provide a systematic framework for educators to identify needs, plan goals, select appropriate content aligned with curriculum standards, design engaging lessons with interactive tools or multimedia resources, implement planned lessons using technology tools while assessing student progress along the way, reflect on practice by analyzing student performance data gathered during assessment process evaluate effectiveness accordingly make informed decisions about future instructions improving overall teaching-learning experience.

There are several practical examples demonstrating how technology can be effectively integrated into math lessons at the elementary level. Educational apps like "Prodigy Math Game" provide a gamified platform where students solve math problems within an immersive virtual world while earning rewards for their progress. Such apps not only reinforce key mathematical skills but also motivate students to engage in continuous practice and improvement. Another example is the use of interactive whiteboards, such as SMART Boards and Tableau software, enable teachers to project digital math resources onto a large screen (Iringan, 2020). This technology allows for dynamic and collaborative problem-solving activities where students can manipulate virtual objects or annotate directly on the board. Interactive whiteboards encourage active participation and facilitate whole-class discussions, promoting a deeper understanding of mathematical concepts (Lahdenperä et al., 2018). Scaffolding is a very effective in teaching ratio and proportion using Easy Scaffolding Design website & Common Core ConceptBank App. GeoGebra has strong potentials in enabling teachers and students dealing with algebraic expressions using guided discovery by virtual manipulatives. Made for Math website and Lastep App have several tools to deal with case studies that students can use to study mathematics and particularly integers and ratio and proportions.

In addition, online resources like Khan Academy and Math Playground interactive lab offer a wide range of instructional videos and practice exercises covering various math topics. Students can access these resources at their own pace, providing opportunities for independent learning and self-assessment (Weinhandl et al., 2021). Online platforms also provide data analytics that allow teachers to track individual student progress and identify areas that require further support or intervention. Technology integration in mathematics education enhances student engagement and motivation by providing interactive activities, visuals, and real-world applications (Firat, 2020). Virtual manipulatives are excellent tools that enable students to visualize abstract

mathematical concepts through hands-on exploration. For example, using virtual fraction bars or base ten blocks helps students develop a concrete understanding of these fundamental concepts before moving on to more complex operations.

Moreover, technology offers opportunities for real-world connections by showcasing practical applications of mathematics in everyday life situations. For instance, students can use spreadsheets or graphing software to analyze data sets or create visual representations of their findings. By making mathematics relevant to their lives outside the classroom, technology fosters intrinsic motivation among students towards learning this subject. One significant advantage of integrating technology into elementary mathematics classrooms is its ability to cater to diverse learners' needs (Al-zboon et al., 2021). Adaptive technologies provide personalized learning experiences tailored to individual differences in learning styles, abilities, or special needs. For example, speech-to-text software assists students with dyslexia or writing challenges in expressing their mathematical thinking effectively.

Furthermore, online platforms equipped with diagnostic assessments can identify students' knowledge gaps and provide targeted interventions accordingly. Adaptive learning systems adjust the difficulty level of problems based on individual performance, ensuring that each student is appropriately challenged while receiving appropriate support. Adaptive technologies play a crucial role in supporting diverse learners in their mathematical understanding. Students with different learning styles or abilities may require alternative modalities to grasp mathematical concepts effectively (Abdillah et al., 2022). For instance, visual learners benefit from interactive graphing tools that allow them to explore relationships between variables and analyze patterns visually. Similarly, auditory learners can leverage text-to-speech features or audio explanations incorporated into educational apps or online resources. By providing multiple modes of representation, technology integration accommodates diverse learner preferences and fosters inclusive mathematics classrooms (Zhang, 2022).

To implement technology-based math assessments effectively, several best practices should be considered. Firstly, it is crucial to align the digital assessments with curriculum goals and objectives (Karma et al., 2019). This ensures that the assessments accurately measure desired outcomes while integrating technology seamlessly into instruction. Secondly, teachers should provide clear instructions and guidelines for using the technology tools employed in math assessments (Ky Long Nguyen et al., 2022). Students need guidance on how to navigate through online platforms or utilize interactive simulations effectively. Regular communication between educators and learners regarding digital assessment expectations further contributes to successful implementation. Assessing learning mathematics with technology integration offers numerous benefits that enhance student engagement, provide immediate feedback, and personalize learning experiences. Techniques such as online quizzes and assessments, gamification, interactive

simulations, adaptive learning systems, and collaborative assessment tools offer opportunities for effective evaluation of mathematical skills and knowledge.

Applying online quizzes and assessment using Google Forms, Kahoot, Class Dojo increase teachers skills in measuring and assessing students learning in mathematics, particularly in ratio and proportion. Interactive simulations, like: Wakelet, The Edvocate, and Google Math Simulator for Children have the ability to help students reflect on their mathematics learning in interesting and entertaining ways. Adaptive mathematics lab, such as: Google Math Shelf and AdaptedMind Math convey students to the virtual mathematics labs where they can show their mastery of learning. Collaborative assessment, such as: MS Teams 365 and Edutopia provide students with the social opportunity to use their mathematics learning to solve problems in collaborative with their classmates, providing them with opportunity to show their goals accomplishment and learn from mistakes. Discussion forums that are beneficial in assessing students in a social atmosphere and publishing their work and project can be MathOverFlow and Students of the World. They are useful in assessing mathematics outcomes in many topics, particularly in integers and linear equations.

It is highly recommended to implement instructional designs that integrate technology effectively into teaching mathematics; educators should follow several best practices. Firstly, they should carefully select appropriate technological tools that align with their learning objectives and standards (Chatain et al., 2022). This ensures that technology enhances rather than distracts from mathematical content. Namely, it is strongly suggested that teachers should also provide clear instructions and expectations to students regarding the use of technology within the lesson (Weinhandl et al., 2021). Specific guidelines on using educational apps or online platforms ensure that students utilize these resources purposefully and stay focused on relevant mathematical tasks. Furthermore, educators should seek ongoing professional development opportunities to enhance their knowledge of technological tools and pedagogical strategies (Lahdenperä et al., 2018). By continuously exploring new technologies in education conferences or online communities, teachers can stay informed about innovative approaches to integrate technology seamlessly into their mathematics instruction.

Conclusion

In conclusion, this study has provided an overview of the results and findings from several studies on technology integration into teaching mathematics. The reviewed studies have demonstrated that integrating technology tools positively impacts students' engagement, motivation, and conceptual development. It is essential for educators to consider the suggested RCERR instructional design stages, teaching strategies, and assessment techniques when implementing such approaches. By following these stages, teachers can enhance mathematics instruction

through technology and promote student engagement, conceptual understanding, critical thinking skills development and collaborative problem-solving. By employing strategies like interactive whiteboards, educational apps, and virtual manipulatives along with best practices for implementation and evaluation methods, educators can create engaging and meaningful mathematical experiences for their students using technology integration (Haris, 2022). By following best assessment techniques and considering the unique needs of their students, educators can harness the power of technology to assess mathematics effectively in today's digital age. Consequently, the implications drawn from these research findings offer valuable insights into how educators can effectively integrate technology in teachings mathematics (Çağlar et al., 2017). The integration of technology in elementary mathematics education has transformative potential for enhancing teaching and learning experiences. It provides numerous benefits such as personalized learning opportunities, increased engagement and motivation, real-world connections, and support for diverse students (Clemence-Mkhope et al., 2019). Practical examples include educational apps, interactive whiteboards, and online resources that facilitate active learning and collaborative problem-solving.

However, challenges such as limited access to technology and the need for teacher professional development must be addressed to maximize the benefits of technology integration in elementary mathematics education (Anita et al., 2021). By leveraging technology effectively, educators can empower students with essential mathematical skills and prepare them for success in an increasingly digital world. Also, solid assessment techniques were discussed in light of integrating technology in teaching mathematics (Caussarieu et al., 2022). In light of these findings, future research should focus on addressing gaps and further explore strategies to enhance technology integration in mathematics education. This collective knowledge serves as a significant step forward in improving educational practices and ensuring students' success in their mathematical learning journey.

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