

## Article

# A Systematic Literature Review on ICT Integration: Opportunities and Challenges in Teaching Mathematics

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**Abstract:** Integrating information and communication technology in modern education is very instrumental in changing the way mathematics is taught and learned. Research in the Philippines explores how ICT is integrated into the country's teaching of math, outlining opportunities and challenges for Filipino teachers and students. This study used a systematic literature review with the aid of the PRISMA framework. A total of 22,800 scholarly articles in Google Scholar was reduced to 994 after title and keyword screening. After the final analysis, 12 articles met all criteria. Literature review shows that integrating ICT into math education offers an incredible number of benefits such as increased student engagement, new pedagogies, improved classroom management, flexibility in learning and teaching, and enhanced assessment. ICT improves contact between teachers and students as it creates possibilities for computer-supported collaborative learning using tools such as virtual manipulatives and simulations to deepen understanding of skills referred to as higher-order thinking. Several challenges still exist despite the benefits. Most schools lack proper ICT infrastructure: reliable internet and enough devices. The budget makes it hard to acquire equipment or relevant software needed for such instruction. Some teachers are not confident and need training in using ICT, and technical support is not adequate. These will only lead to uneven use of ICT in classrooms, hence limiting the possible impact on mathematics teaching. Infrastructural improvements, funds, and training of teachers, when coupled with technical support, might propel more efficient integration of ICT in math instructions within Philippine education. These will build vibrant learning environments that pave the way for learners toward success in a world increasingly dominated by digital technology.

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## 1. Introduction

Mathematics is powerfully important because it helps us to make sense of the world around us. It allows us to solve problems, notice patterns, and make predictions. Through mathematics, students can learn some important and viable analytical and critical thinking skills. It is in technology, science, engineering, and economics; it is in our everyday lives as we create, innovate, and understand our world better.

However, many struggle with math, and this has been a problem for a long time. It affects how people deal with their personal lives, social interactions, and public responsibilities (Anthony & Walshaw, 2023). On this basis, it is concluded that only three things make mathematics difficult for students: teachers, students themselves, and the environment that limits their interaction. One or more of these

three factors, if as good as left unnoticed, might also lead to the waste of most students' potential (Langoban, 2020).

These topics challenge the student to think critically and solve problems. It recognizes that students have been accustomed to a step-by-step way of learning mathematics. This is the reason teachers are encouraged to design activities that would give satisfaction by exploring and investigating newly acquired thoughts and ideas through recommended activities by Silerio (2020).

In the Philippine setting, recent results from the Program for International Student Assessment (PISA) pointed out a disturbing upward trend wherein students are falling behind their global peers on measures of math proficiency. The gap presented a challenge for educators and policymakers to seek innovation, such as the integration of Information and Communication Technology in mathematics education.

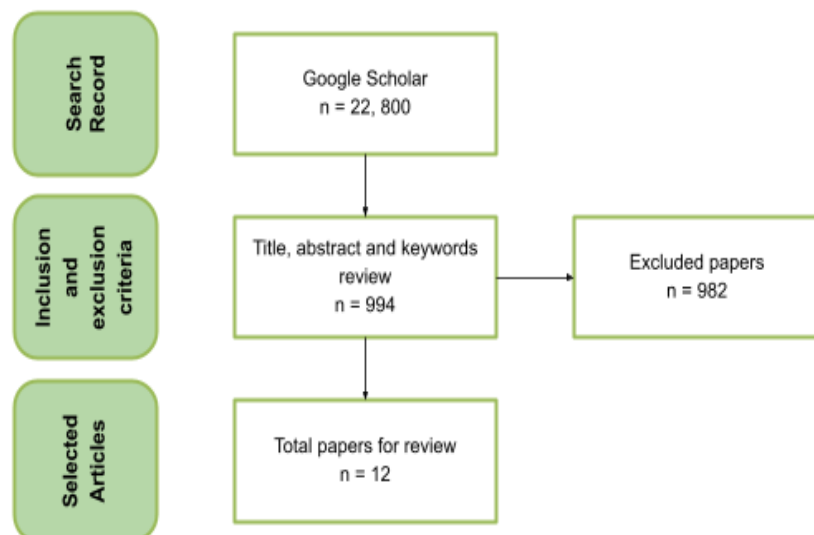
Mindful of the large quantity of literature that is now available about ICT integration, the researcher performs a systematic literature review to outline current research findings on effective strategies in enhancing mathematics learning through the use of ICT. It can, then, address these issues, adding to the improvement in academic performances and attainment of a much deeper understanding of mathematics among Filipino students (Lima, 2024).

## 2. Materials and Methods

This systematic literature review using PRISMA framework is aimed to comprehensively examine studies concerning the integration of Information and Communication Technology (ICT) in mathematics education within the Philippines, focusing on both opportunities and challenges. The review followed a structured approach to ensure a rigorous selection and analysis of relevant literature.

The search strategy involved querying the Google Scholar academic database using predefined keywords such as "ICT integration", "opportunities and challenges", "Philippines", and "mathematics". Studies included in the review were selected based on their relevance to the topic, focus on Mathematics education in the Philippines, recency (published between 2019 to present), and contribution to understanding ICT integration in educational contexts.

**Figure 1.** PRISMA Flow Diagram



**Figure 1.** Process of systematic search and selection, such as the number of records screened, the number of records evaluated for eligibility, and the number included in the final review.

A systematic screening process was employed to assess each study's eligibility based on title, abstract, and keywords. Initially identifying a total of 22,800 records. All identified records were first screened based on their titles. Keywords were analyzed to identify studies that were relevant to the research subject. For the remaining records, abstracts were reviewed to further assess the relevance and alignment of the study's objectives (Leavy, 2023). All these were done to ensure that the screening process is thorough and methodical, focusing on titles, keywords, and abstracts screening process, so these narrowed down to 994 potentially relevant studies. Following a full-text assessment against inclusion and exclusion criteria, 12 studies were deemed suitable for detailed analysis.

This methodological approach ensured a thorough review of current literature on ICT integration in Mathematics education within the Philippines, providing a foundation for exploring both the transformative opportunities and persistent challenges associated with educational practice.

### 3. Results

The present research deals with the integration of ICT into mathematics teaching, considering the opportunities offered and the challenges arising. We split our research into these two areas to bring about more comprehensive knowledge of the impact of ICT on mathematics education. In the study of opportunities, we emphasize ways in which ICT can enrich mathematics teaching and learning with innovative tools and approaches. On the other hand, by identifying challenges, we are aware of the obstacles that need to be addressed in the process of effectively using ICT in education. It is a balanced approach that shall enable us to understand both the positive potential and the issues paving the way toward successful integration of ICT in mathematics education.

**Table 1: Distribution of Publications**

Research Areas	Publication Year	Number of Papers	References
Opportunities in ICT Integration	2019	2	Roble et al. (2019) Viojan et al. (2019)
	2021	2	Alcantara et al. (2021) Ibañez et al. (2021)
	2023	4	Flores (2023) Gamit (2023) Bartolome (2023) Pasayloon (2023)
	2024	1	Honrado (2024)
Challenges in ICT Integration	2019	1	Romantico (2019)
	2021	2	Alcantara et al. (2021) Nobis (2021)
	2023	4	Gamit (2023) Pastor & Pedro (2023) Bartolome (2023) Pasayloon (2023)

	2024	1	Honrado (2024)
<b>Total</b>	12		
<b>Same Research</b>	5		

There are a total of 12 researches used in this systematic literature review. Five of these focused on both opportunities and challenges.

### Opportunities in ICT Integration

Information and Communication Technology (ICT) has become so deeply integrated into education that they noticeably improve student engagement, innovative teaching methods, classroom management, flexible learning, and the assessment process. These advancements are interconnected, creating a cohesive and dynamic educational environment.

According to Roble et al. (2019), the integration of ICT into mathematics education has a strong influence in classroom management and student behavior. Teachers commented that with technology, students were interested in class and had enhanced motivation. Technology helped teachers communicate better with their students, assisted collaborative learning among peers. ICT contributed to concentration and attentiveness among the learners, thus better classroom discipline and behavior. The use of technology allows a teacher to help students learn how concepts are done by the use of mathematical web-based virtual manipulatives and problem-solving simulations (Tiernan, 2022). This integration emphasizes, therefore, pedagogical strategies in an acting positive climate of learning that helps get the students to participate and learn academically.

Viojan et al. (2019) and Flores (2023) highlight that ICT competence among teachers is crucial for effective assessment and feedback in education. A competent user of ICT increases the effectiveness of teaching, especially for mathematics. ICT tools make students more focused and efficient in completing the tasks assigned to them and more cognitively engaging, causing excitement in learning. These will also provide feedback to learners immediately, allowing them to monitor their progress and effortlessly determine where more practice is needed. Assessment processes and activities using ICT incorporate higher order thinking skills, such as reasoning, decision-making, and strategic planning. Viojan (2019) adds that one of the uses of ICT in education, in their work, is for professional development and training, since it empowers teachers to improve their pedagogical methods, foster various learning needs, and enhance their ability in order to give personalized feedback and conduct assessments.

Alcantara et al. (2021) further indicate that utilizing modern tools maximizes innovative pedagogical practices in mathematics education. This approach enables teachers to effectively engage 21st-century learners, adapting their methods to suit different kinds of learners. As a result of this, students show interest and attention in math classes. For teachers to be able to fit these tools into the curriculum, they need to change practices to meet up with K-12 curriculum standards ensuring education remains relevant and engaging (Aquilina, 2024). By engaging tools such as PowerPoint in the classroom, teachers make learning more dynamic by creating environments that encourage active participation and deeper understanding, transforming traditional teaching into innovative experiences.

Ibañez et al. (2021) explains that the use of modern applications in mathematics education enhances flexibility and accessibility to learning. There is an increase in the levels of experimentation, collaboration, and interactive exploration with mathematical concepts using tools. This enables students to engage themselves more

with the material. They also provide diverse educational resources that promote personalized learning experiences in the classroom. These digital resources, covering all kinds of learning, foster global competence and digital literacy. These are core competencies that will help students fit into practical life. The integration of learning tools available through flexible learning helps solve spiral progression teaching challenges while preparing learners for a time when the world is digitally connected.

This shift in teaching and learning methods, as noted by Gamit (2023) and Bartolome (2023), innovates traditional educational approaches. With the use of ICT, teachers are able to communicate directly with the parents concerning the performance of their children, thus fostering better relations with the parents. Furthermore, ICT helps in preparing, organizing, delivering, and monitoring academic tasks—deviation from the traditional ways of doing things. In this aspect, technological integration enables a quality process of teaching through engaging instructional activities and empowers the teacher in creating curricular designs that answer diverse learning needs. With proper training in ICTs and support, teachers can create interactive learning environments, hence improving professional development and equipping students with critical skills needed in the digital era (Ruiz-Cecilia, 2023).

Finally, Pasayloon (2023) and Honrado (2024) emphasize that integration of ICT into mathematics education significantly impacts students by engaging them and fostering their interest in the subject. Pasayloon declares that with these digital learning tools, such as virtual manipulatives and simulations, the possibility for pupils to delve into mathematical knowledge increases in terms of the level of interactivity, enhancing deeper understanding and higher-order thinking. The addition of Honrado is that computer-based learning provides flexible access to a huge number of educational resources; therefore, it motivates students to learn anytime and anywhere, improving understanding and critical thinking. The collective results of these studies have shown that ICT is a way to offer an active and cooperative learning environment, increasing students' interest and participation in mathematics.

The integration of ICT in mathematics education fosters engaging, innovative, and student-centered learning experiences. It is a potential of technology which raises curiosity among students, gives basic knowledge, and enables them to be prepared for the challenges of the digital era.

### **Challenges in ICT Integration**

Technology serves as a valuable tool for both teachers and students. However, if there are benefits and opportunities in integrating ICT in Mathematics education here in the Philippines, there are also challenges and considerations that need to be addressed in order to have an effective and successful ICT integration.

One of the challenges in ICT integration is associated with infrastructure and resources. Managing a crowded classroom poses difficulties in the use of ICT in teaching mathematics (Bartolome, 2023). Moreover, Alcantara (2021) revealed that the absence or the slow internet connection is an obstacle to the utilization of the supposed available resources in various reliable websites. Studies by Gamit (2023), Bartolome (2023), Romantico (2019) and Pasayloon (2023), emphasize that lack or insufficient supply of ICT devices, and software hinders the delivery of high-quality, interactive lessons that utilize digital resources, impacting student engagement and learning outcomes.

Additionally, as highlighted in the study of Nobis (2021) and Bartolome (2023), lack of funding from the school is a contributing factor to insufficient ICT resources. Without sufficient funding, schools struggle to procure an adequate number of

computers and ensure reliable internet access which can be used to incorporate digital tools into daily lessons. As a result, it limits students' access to technology and also hinders teachers' ability to implement interactive and engaging teaching methods that use ICT. Moreover, the lack of investment in instructional software and electronic resources reduces educational experience, thus depriving learners of the opportunities to acquire digital literacy skills and modern learning approaches.

On the other hand, Alcantara (2021) noted that some teachers lack confidence in integrating ICT. As stated in the studies by Bartolome (2023) and Romantico (2019), lack of training and seminars related to ICT integration in Mathematics teaching is one of the complaints of the teachers since they really believe that with these, they can gain learning and they can transfer it to their students. Teacher's limited knowledge on ICT makes them feel anxious about using ICT in the classroom. Thus, lack of knowledge makes a teacher less competent and it would lead to lack of confidence.

Teacher readiness, attitudes and beliefs towards technology also affects ICT integration. Across different age groups, challenges related to these factors persist. For instance, the result of the study of Honrado (2024) implies that one common stereotype is that old teachers are less inclined to use technology. It may be true for some educators, but it is crucial to recognize that this is not the case for all other older teachers. Moreover, as noted by Bartolome (2023), inadequate technical support adds burden to the teachers. This may lead to disruption in lesson delivery hence the teachers may get frustrated and become less interested in integrating ICT in teaching. When there is a lack of effective technical support, then troubleshooting and maintaining of the ICT equipment can become problematic for the teachers, thereby affecting the sustainability of the ICT integration efforts.

Furthermore, according to the findings of Pastor and Pedro (2023), it is time consuming to prepare ICT-enriched instruction therefore its application usually only occurs once or twice a week. This irregular integration is further complicated by inconsistent implementation of technology in schools which Pasayloon (2023), identifies as the source of teachers' unfamiliarity with the ways to seamlessly integrate technological tools in instructional practices.

These challenges found in different studies highlight the complexities involved in integrating ICT effectively in classrooms, particularly in enhancing Mathematics education in the Philippines. Issues such as insufficient infrastructure and resources, lack of funds, lack of confidence and knowledge, lack of training and seminars related to ICT integration, teacher readiness, attitudes and beliefs towards technology, inadequate technical support and inconsistent technology integration in schools pose significant barriers to achieve successful integration of ICT in teaching and learning process. Thus, addressing and overcoming these challenges will help educators as well as students to fully utilize and benefit from ICT (Information and Communication Technology) integration in mathematics education.

#### **4. Conclusion**

Based on this systematic literature review, the integration of ICT into teaching and learning mathematics in the Philippines provides varied opportunities and challenges.

The integration of ICT in mathematics education offers a wide scope of the possibilities for student engagement, innovative pedagogical practices, effective and flexible classroom management, and efficient assessment of practices. Teachers can harness the potential of this technology in creating active learning environments that

guide students to deep understanding, higher-order thinking, and better classroom management while preparing them for the challenges of the digital age.

However, some of these opportunities are faced with immense challenges that are serious and need to be overcome for ICT to play the intended role. Some of the challenges recognized include the lack of enough infrastructure and resources, inadequacy in school funding, lack of confidence and knowledge about integration among some teachers, teachers' readiness and beliefs toward technology, fairness in terms of teachers' readiness for information and communication technology, lack of efficient technical supports, the time-consuming process of preparing ICT-enriched instructions, and inconsistency in technology implementation in schools. This would need collaboration from the policymakers, educators, and stakeholders toward the effective integration of ICT into instruction, hence improving mathematics education in the country.

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