

Application of Information Technology in Teaching Mathematics in Primary Schools – Potentials And Challenges for Teachers And Students

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ABSTRACT:

In the context of digital transformation and innovation in general education, the application of information technology (IT) to improve the quality of mathematics teaching in primary schools is becoming increasingly necessary. IT not only helps teachers visualize knowledge, diversify learning materials, and organize interactive activities but also enables students to increase their interest, proactively practice, and develop their mathematical abilities. This article focuses on surveying the current situation of IT application in teaching mathematics in primary schools, analyzing the potentials and challenges for teachers and students, as well as the factors affecting the effectiveness of technology use. Based on a review of research and practical surveys, the article proposes some directions for the appropriate, balanced, and safe use of IT, thereby contributing to the development of teachers' digital pedagogical competence, students' digital self-learning competence, and mathematical competence in primary school students.

Keywords: Information Technology; Mathematics teaching; Primary education; Teachers; Students; Potentials; Challenges.

1. Introduction

The rapid development of information technology (IT) and the digital transformation process are creating significant changes in education. Digital devices, teaching software, online learning materials, and interactive tools not only expand access to knowledge but also facilitate innovation in methods, forms of organization, and assessment. In this trend, IT is considered an important support tool to

enhance learner engagement, promote personalization, and develop learning competencies in the digital environment.

In Vietnam's new general education curriculum, mathematics in primary school plays a role in forming and developing logical thinking, problem-solving skills, modeling abilities, and the capacity to apply knowledge to practice. However, some topics such as Numbers and Calculations, Geometry, Measurement or

Statistics are abstract, while visual thinking and concrete manipulation remain important for primary school students. IT, through images, videos, dynamic models, games, and interactive exercises, can help teachers visualize knowledge, design exploratory activities, and provide timely feedback. For students, technology can create interest, increase manipulation opportunities, support practice at their own pace, and connect mathematical knowledge with real-world situations.

However, the presence of information technology does not automatically ensure teaching effectiveness. Teachers not only need skills in using devices and software but also must know how to choose technology appropriate to the objectives, content, and cognitive characteristics of students. Building digital learning materials requires time, digital pedagogical competence, and the ability to verify content accuracy. If used incorrectly, IT can lead to lessons that focus too much on presentation and effects, reducing opportunities for calculation, reasoning, presentation, and direct interaction.

For primary school students, information technology offers expanded learning opportunities while also posing challenges related to self-control, information seeking, and evaluation skills. Students may be interested in games, videos, and online exercises but may not necessarily understand the mathematical concepts deeply. Imbalanced use can also lead to distraction, dependence on devices or ready-made solutions, and hinder the development of fundamental mathematical skills. Differences in devices, internet connectivity, and family support can also create disparities in access opportunities.

Numerous studies have clarified the many benefits of ICT in visualization, increasing interaction, and supporting personalized math learning. However, many works have primarily focused on a specific software or teaching method; they have not simultaneously considered the potentials and challenges for both teachers and primary school students in

the same context. In particular, the comparison of teachers' assessments with students' direct experiences has not yet received sufficient attention.

This article presents a survey of the application of ICT in teaching mathematics in some primary schools in Hanoi, thereby analyzing the potentials and challenges for teachers and students. The study focuses on answering three questions:

- How do teachers and students assess the ability to utilize digital devices, software, and learning materials in teaching mathematics?
- What potential benefits does ICT bring to teachers and students?
- What challenges do teachers and students encounter during the application of ICT?

2. Research Overview and Theoretical Framework

The application of ICT in teaching mathematics in primary schools is a purposeful integration of devices, software, and digital learning materials with mathematical content and pedagogical methods to support students in forming knowledge, developing thinking, and mathematical competencies.

Hattie (2009) and Hattie et al. (2017) argued that technology only becomes effective when linked to learning objectives, cognitive activities, and appropriate feedback. Hohenwarter et al. (2008) pointed out that dynamic mathematics software like GeoGebra allows learners to manipulate, experiment, and observe the transformations of mathematical objects, thereby supporting knowledge discovery and the development of geometric thinking.

The ability to visualize is particularly suitable for the cognitive characteristics of primary school students. Images, videos, and dynamic models help them access abstract content, gradually transitioning from concrete manipulation to symbolic and abstract thinking. In Vietnam, Nguyen Ba Kim (2012) emphasized the role of visual aids and

exploratory activities in forming mathematical knowledge. Nguyen Van Bien et al. (2019) showed that STEM education facilitates the connection of mathematics with technology, other subjects, and real-world issues.

For teachers, ICT supports the exploitation of learning materials, task design, interaction organization, activity differentiation, and feedback on learning outcomes. For students, technology contributes to creating interest, increasing practice opportunities, and supporting the application of knowledge. However, the actual effectiveness still depends on the purpose of use, the quality of learning materials, the teacher's digital pedagogical competence, and the active participation of students.

Mishra and Koehler's (2006) TPACK model identifies that effective ICT application requires the integration of technological knowledge, pedagogical knowledge, and content knowledge. Trouche's (2004), Trouche and Drijvers' (2010), and Drijvers et al.'s (2010) theory of pedagogical coordination further affirms the teacher's role in selecting tools, designing tasks, and coordinating learning activities. For teachers, the challenge is not only operating the equipment but also selecting appropriate technology, verifying content, and designing tasks with cognitive value. Creating digital learning materials and using specialized software requires time, skills, and support. If presentation slides, effects, or automatic exercises are overused, the lesson may be visually appealing but reduce students' opportunities for reasoning and explaining their solutions. For primary school students, technology can be distracting and create dependence on devices or ready-made solutions. Device usage skills do not equate to digital self-learning ability. Students still need guidance in searching for and verifying information and using technology safely. Differences in devices, internet connectivity, and family support also affect learning opportunities.

Studies have clarified the role of ICT in visualization, increasing interaction, and supporting feedback. However, there is a lack of studies that simultaneously analyze the potentials and challenges for both primary school teachers and students, as well as compare teachers' assessments with students' experiences.

Therefore, the article constructs an analytical framework based on two subjects. For teachers, the research examines technological proficiency, learning material design, activity organization, assessment, and data security. For students, the research focuses on interest, participation level, device usage ability, self-study, resource exploration, use of mathematical thinking tools, and digital safety.

3. Practical Research

We conducted a practical study to understand the extent and forms of ICT application in teaching elementary school Mathematics; at the same time, we identified the potentials and challenges encountered by teachers and students in the process of using technology.

3.1. Research Subjects and Location

The survey was conducted at some elementary schools in Hanoi. The survey sample included 26 principals and teachers, consisting of 2 principals, 5 subject team leaders, and 19 teachers directly teaching Mathematics; simultaneously, 105 students from grades 3, 4, and 5 were surveyed.

The schools were selected using a convenience sampling method, based on accessibility and willingness to participate in the survey. Students in grades 3, 4, and 5 were chosen because they possess reading comprehension skills, can self-assess, and respond to questionnaires. The research results reflect the current situation of the surveyed group and do not represent all elementary school teachers and students in Hanoi.

3.2. Research Methods and Tools

The study used a questionnaire survey method; some observational information was used to support interpretation but was not analyzed as

an independent data source. The questionnaire was designed on a four-point Likert scale, corresponding to points 1 through 4. The questionnaire for administrators and teachers focused on four content areas: awareness of ICT's role; extent and form of application; proficiency in using devices, software, and digital learning materials; potentials and challenges in teaching Mathematics. The questionnaire for students was phrased concisely, suitable for their age, focusing on learning interest, device usage level, online assignment completion ability, self-directed learning material search, and use of mathematical thinking support software. The survey was conducted on a voluntary basis, ensuring anonymity; students were explained the purpose and how to answer the questionnaire in age-appropriate language.

3.3. Data Processing and Analysis

Quantitative data was processed using descriptive statistics, including frequency, percentage, and average score. The average score for each indicator was calculated using the formula:

$$\bar{X} = \frac{(\sum f_i \times x_i)}{N}$$

Where, $\bar{X}$ is the average score; x_i is the score for the response option; f_i is the number of people who chose the option, and N is the total number of participants. The average score is interpreted on four levels: 3.25–4.00: very high; 2.50–3.24: high; 1.75–2.49: low; 1.00–1.74: very low. For negative statements, a

higher score indicates a greater level of challenge. Some observational information was used to support the interpretation of survey results but was not analyzed as an independent data source.

4. Research Results

The results are presented in three sections: the ability to utilize devices, software, and digital learning materials; potentials recognized by teachers and students; and challenges encountered during the teaching and learning of Mathematics.

4.1. Ability to Utilize Devices, Software, and Digital Learning Materials

Survey results from 26 principals and teachers indicate that this staff has a foundation in using common IT devices and tools. The ability to use computers, projectors, and interactive whiteboards achieved an average score of 3.31. The ability to utilize interactive tools like Quizizz and ClassPoint scored 3.35, while the usage level of general Mathematics teaching software reached 3.08.

However, the ability to design digital learning materials only reached 2.12 points, lower than the ability to operate equipment and use available tools. This result shows that teachers are relatively comfortable using equipment, presentation slides, or interactive platforms but face more difficulties in activities requiring high technological competence, such as designing videos, simulations, and digital learning materials.

Table 1. Teachers' ability to utilize IT equipment and tools

Survey content	Average score
Utilizing Quizizz, ClassPoint, and interactive tools	3,35
Proficiently using IT equipment	3,31
Using software for teaching Mathematics	3,08
Designing digital learning materials	2,12

The data above reflects the self-assessment level of technology utilization ability, not the frequency of use in each lesson. Therefore, the

results are not sufficient to accurately determine the number of times teachers use IT or the most frequently used tools. However,

the discrepancy between the ability to use equipment and design learning materials indicates that the application of IT still leans towards utilizing available tools rather than creating in-depth digital learning materials.

For students, 83.8% of those surveyed chose “very true” or “true” for the statement that they often use computers, tablets, or phones to do online Math exercises. The average score for this indicator reached 3,25. The results

show that most students have experience using devices to complete online learning tasks. However, this data does not fully reflect the quality of device usage or the students' proactivity.

4.2. The potential of IT for teachers and students in teaching and learning Mathematics

4.2.1. Potential for teachers

Table 2. The potential of IT according to the assessment of principals and teachers

Survey content	Proportion of agreement and strong agreement	Average score
Enhancing visualization, supporting mathematical thinking	96,1%	3,65
Increasing interest in learning Mathematics	96,2%	3,62
Alignment with the direction of the curriculum innovation program	96,1%	3,58
Students interact well with games and videos	88,5%	3,38
Students are capable of completing online exercises	88,5%	3,35

The survey results show that IT expands teachers' ability to organize Mathematics teaching in three aspects: tool utilization, knowledge visualization, and interactive activity organization. The ability to utilize Quizizz, ClassPoint, and interactive tools reached 3,35 points; the ability to use IT equipment reached 3,31 points; using software for teaching Mathematics reached 3,08 points. These results indicate that teachers have a technical foundation for using technology in lesson design and organization.

The most prominent potential is supporting the visualization of knowledge and mathematical thinking, reaching 3,65 points. Through images, videos, dynamic models, and mathematical software, teachers can represent difficult-to-observe content, illustrate object transformations, and organize students to manipulate, predict, and verify results. IT

therefore not only supports lesson delivery but also expands the ability to design exploratory situations and form knowledge.

The ability to increase learning interest reached 3,62 points, while students' interaction with games and videos reached 3,38 points. The results show that IT facilitates teachers in diversifying organizational methods, using interactive questions, games, and online exercises to increase student engagement. The results suggest that digital tools can support teachers in organizing interaction and feedback during the learning process.

Alignment with the direction of the 2018 General Education Curriculum innovation reached 2018 points. The results show that IT is consistent with the direction of innovative teaching methods, in which teachers can design diverse tasks and enhance practical connections. 2018 3,58

However, this potential has only been exploited mainly through available devices and tools. The ability to design digital learning materials scored 2,12 points, indicating that teachers have not yet strongly transitioned from users to designers of digital learning materials. Therefore, the potential of ICT for teachers still depends on their ability to use technology, preparation time, and the ability to choose technology appropriate for the lesson objectives.

4.2.2. Potential for Students

Direct survey results from 105 students show a relatively positive attitude towards learning Math using ICT. 88,6% of students chose “very true” or “true” for the statement that they like learning Math through games, videos, and online exercises; the average score was 3,38. Additionally, 83.8% of students reported frequently using devices for online assignments, scoring 3,25 points.

Table 3. Student Assessment of Some Benefits of ICT

Survey Content	Percentage of “very true” and “true”	Average Score
Like learning Math through games, videos, and online exercises	88,6%	3,38
Frequently use devices for online Math assignments	83,8%	3,25
Confident in completing online assignments without much guidance	75,2%	3,06

The assessment by students and the perception of teachers both indicate a trend: ICT has the potential to create interest and support students in participating in online learning activities. However, the two indicator groups do not measure exactly the same concept, so the similarity should only be considered descriptive evidence, not absolute agreement between the two groups of subjects.

A high level of preference does not necessarily equate to the ability to self-learn or deeply understand mathematical knowledge. The results should be considered alongside the limitations in self-searching for materials and using software to support thinking, which will be presented in the next section.

4.3. Challenges of ICT for Teachers and Students in Teaching and Learning Mathematics

4.3.1. Challenges for Teachers

Table 4. Challenges for Teachers

Challenge	Average Score
Uneven application of ICT among teachers	3,42
Limited exploitation of specialized mathematics software	3,31
Primarily applying ICT at a basic level	3,19
Not all lessons are suitable for integrating ICT	3,03
Preparing ICT-integrated lessons is time-consuming	3,00
Limited ability to design digital learning materials	2,88

The results in Table 4 show that the biggest challenge is the unevenness in ICT skills and application levels among teachers, scoring 3,42 points. Limitations in exploiting specialized mathematics software scored 3,31 points; primarily applying ICT at a basic level scored 3,19 points. This indicates that teachers find it relatively easy to use available devices and tools but struggle with exploiting technology at a specialized level.

Difficulties in selecting appropriate content for ICT integration scored 3,03 points; preparation time for lessons scored 3,00 points. This is not only a technical issue but also relates to digital pedagogical competence, as teachers must choose technology appropriate for the

objectives, content, and characteristics of the students.

The ability to design positive digital learning materials scored 2,12 points, while the perception of limitations in designing learning materials scored 2,88 points. These two opposing indicators both suggest that designing learning materials is a notable weakness. However, these figures should only be used for descriptive comparison and not considered as two independent pieces of evidence.

Overall, the challenges for teachers lie not primarily in operating devices but in their ability to select technology, design learning materials, and organize learning activities with cognitive value.

4.3.2. Challenges for Students

Table 5. Difficulties of students in learning Mathematics with IT applications according to the assessment of principals and teachers

Survey Content	Assessment Source	Score average
Students' self-learning ability on digital platforms is still limited	Principals and teachers	3,42
Students use mathematical thinking support software infrequently	Principals and teachers	3,30

Note: Table 5 uses statements in the negative direction; high scores indicate a greater degree of difficulty

Table 6. Students' ability to use IT in learning Mathematics

Survey Content	Assessment Source	Score average
Students search for videos, lectures, and Mathematics materials on the Internet by themselves	Student self-assessment	2,97
Students know or have used software for drawing figures and simulations	Student self-assessment	2,81
Students have the ability to self-learn Mathematics on digital platforms	Managers and teachers	2,69
Students have the ability to use mathematical thinking support software	Managers and teachers	2,54

Note: Table 6 uses statements in the positive direction; high scores indicate a higher level of ability.

According to the assessment of principals and teachers, students' self-learning ability on digital platforms is still limited, scoring 3,42 points in the negative direction; the infrequent use of mathematical thinking support software scored 3,30 points. The results show that students have accessed technology but are not proactive in choosing learning materials and tools for learning Mathematics.

Indicators in the positive direction further clarify this trend. The ability to self-search for learning materials scored 2,97 points; using software for drawing figures and simulations scored 2,81 points; self-learning on digital platforms scored 2,69 points; using mathematical thinking support software scored 2,54 points. These results are all lower than the ability to use devices for online assignments, which scored 3,25 points.

The data shows that students achieve better results in activities involving manipulation and performing given tasks, but lower in activities requiring proactivity and the use of specialized tools. Therefore, the significant challenge is the gap between "knowing how to use devices" and "knowing how to use technology for self-learning and developing mathematical thinking".

4.4 Discussion

The research results above show that potential and challenges do not exist separately but are directly related. The ability to create interest is at a high level, but students' self-confidence and self-learning ability are lower. Teachers use devices and interactive platforms relatively well, but their ability to design learning materials and use specialized software is limited. Thus, technology has been accessed at the usage level, but leveraging technology to develop thinking and self-learning abilities remains an issue that needs continuous improvement.

For teachers, the potential of IT can only be realized when technical skills are combined with Mathematics knowledge and pedagogical methods. For students, interest and manipulation skills only become learning abilities when they know how to choose tools,

reason, check results, and self-regulate the learning process. Therefore, the survey results not only indicate the need to increase the use of IT but also raise the requirement to improve the quality and depth of technology use.

The research results show that visualizing knowledge and creating interest are the most prominent potentials of IT in teaching Mathematics. This finding is consistent with Hattie and studies on dynamic mathematics software, according to which technology can assist students in observing, manipulating, and recognizing mathematical relationships when linked with appropriate learning goals and tasks.

For elementary students, images, videos, models, and interactive exercises align with their visual thinking characteristics, thereby increasing interest and participation. However, a fondness for technology does not equate to students deeply understanding knowledge or achieving higher academic results. The value of IT is only realized when students truly manipulate, reason, explain, and apply mathematics.

The results also indicate that teachers can use interactive devices and tools relatively well but have limitations in designing digital learning materials and utilizing specialized mathematical software. This gap aligns with the TPACK model, as effective technology integration requires a combination of technological knowledge, content, and pedagogical methods. Simultaneously, according to pedagogical orchestration theory, the value of digital tools depends on how teachers select, organize, and guide learning activities, not just on technical proficiency.

For students, familiarity with using devices does not equate to digital self-learning ability. They may complete pre-designed online tasks but have limitations in independently searching for learning materials, verifying information, and using software to support mathematical thinking. Therefore, students still need guidance on how to select tools and self-regulate their learning process.

Overall, the potential and challenges of IT go hand in hand. Images and games can generate interest but also easily distract attention; automated feedback helps detect errors quickly but does not fully reflect the reasoning process. Therefore, the effectiveness of IT application should be evaluated by the quality of mathematical tasks and students' cognitive engagement, rather than solely by the frequency of use.

6. Conclusion

The research shows that IT has great potential in teaching mathematics in elementary schools, notably in supporting knowledge visualization, generating interest, enhancing interaction, and expanding practice opportunities. Teachers have a relatively good foundation in using devices and common interactive tools. Students also demonstrate positive attitudes, have experience using devices, and participate in online math learning activities.

However, this potential has not been exploited uniformly or fully. Teachers still face difficulties in designing digital learning materials, utilizing specialized mathematical software, and selecting technology appropriate for lesson objectives. While students are familiar with using devices, their proactivity in self-learning, searching for materials, verifying information, and using tools to support mathematical thinking needs improvement. These results confirm that owning devices or mastering technical operations is insufficient to ensure effective teaching and learning.

Based on the research findings, we propose several points to consider:

- Select technology based on required learning outcomes and the nature of mathematical knowledge. Teachers should only use IT when technology helps students observe, manipulate, explore, or solve tasks more effectively.
- Design learning activities to foster thinking. Students need to predict, experiment, explain,

present their solutions, and apply knowledge, rather than just viewing presentations or selecting answers.

- Enhance teachers' digital pedagogical competence. Training content should focus on designing learning materials, utilizing mathematical software, differentiating tasks, verifying accuracy, and evaluating the effectiveness of technology on learning.

- Develop students' digital self-learning skills step by step. Teachers need to guide students in identifying learning needs, using appropriate learning resources, verifying information, and self-assessing outcomes.

- Use online resources in a controlled manner. Teachers need to verify content generated by technology; students need to be guided not to rely on ready-made solutions and not to provide personal information on insecure platforms.

- Ensure a balance between digital and direct activities. Online exercises should be combined with writing, calculation, using learning tools, group discussions, and verbal presentations to maintain fundamental mathematical skills.

Evaluate IT effectiveness based on student progress. The evaluation should not solely rely on the frequency of technology use but should consider the ability to understand knowledge, the quality of reasoning, the level of proactivity, and the ability to apply mathematics.

IT does not replace mathematical thinking, direct experiential activities, or the pedagogical role of the teacher. Technology is only truly valuable when it is purposefully selected, appropriately integrated with the content, and facilitates active student participation in the knowledge construction process. Therefore, the application of IT in teaching mathematics in primary school should be implemented in a suitable, balanced, safe manner, with the development of students' mathematical competencies as the central criterion.

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