



## Using interactive electronic textbooks to improve mathematics achievement and problem-solving competence among primary school students

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### Abstract

This study investigates the effectiveness of interactive electronic textbooks in enhancing mathematics achievement and problem-solving competence among primary school students. A quasi-experimental design was implemented with two groups of first-grade students ( $n = 60$ ) over a four-week instructional period. Quantitative data were collected through pre-test and post-test assessments, while qualitative data were obtained from classroom observations and semi-structured interviews with students and teachers. The results of independent and paired t-tests revealed that students in the experimental group achieved significantly higher post-test scores than those in the control group ( $p < 0.001$ ), with a large effect size (Cohen's  $d = 1.26$ ). Beyond academic performance, students using interactive electronic textbooks demonstrated greater flexibility in problem-solving strategies, higher levels of self-correction, and increased learning motivation. Qualitative analysis further indicated that multimedia elements, real-time feedback, and touch-based interaction supported student engagement, conceptual understanding, collaboration, and persistence in challenging tasks. These findings align with Mayer's multimedia learning theory and Vygotsky's constructivist perspective, suggesting that scaffolded digital interactions can facilitate knowledge construction through exploration, reflection, and revision. Overall, the study provides empirical evidence for the pedagogical value of interactive electronic textbooks in early mathematics education and offers practical implications for digital curriculum design and technology-supported learning environments in primary schools.

**Keywords:** Constructivism, Digital pedagogy, Interactive electronic textbooks, Mathematics learning, Multimedia learning, Primary education, Problem-solving skills.

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## Contents

1. Introduction .....	187
2. Literature Review .....	187
3. Research Method .....	188
4. Results .....	191
5. Discussion.....	193
6. Conclusion .....	193
References.....	194

### Contribution of this paper to the literature

This study is original and represents the authors' own work. It has not been published previously, nor is it under consideration for publication elsewhere. The research is unique because it is the first in the Vietnamese context to systematically evaluate the impact of using interactive electronic textbooks on mathematics achievement and problem-solving competence among primary school students.

## 1. Introduction

Within the past two decades, digital technology has developed rapidly in education (Timotheou et al., 2023). One of the most marked transformations is the development and spread of interactive electronic textbooks, which are treated as an essential educational means to substitute traditional paper books expediently, compensating for their shortcomings (Li et al., 2020; Tlili et al., 2024; Yorganci & Subasi, 2025). This book has many advantages, including convenience and multimedia usage, as well as flexible access, and is beneficial to teaching and learning while affording the opportunity for enhancing educational efficacy under different circumstances (Sigarchian et al., 2018). Interactive electronic textbooks have been shown in empirical research to improve learning outcomes, boost motivation and interest in learning, and help students develop higher-order thinking skills (Jácome-Guerrero, Román, Barreno, & Parra-Gavilánez, 2024; Septiana, Yulianti, & Nurcahyo, 2023; Sung, Hwang, & Chen, 2019; Yorganci & Subasi, 2025). They additionally aid students in maintaining focus and enhancing knowledge retention by offering visually rich and dynamic representations (Gu, Wu, & Xu, 2015).

Interactive electronic textbooks are increasingly recognized as a crucial tool to assist the invention of teaching methods in educational innovation, especially at the elementary level (Wijaya, Cao, Xiao, Rahmadi, & Gong, 2025). Students build fundamental mathematical and logical thinking skills at this point, which are critical talents with long-term cognitive importance (Tsai, Shen, & Lu, 2015; Yang, Wu, & Ogata, 2025). Electronic textbooks are considered particularly suitable for developing students' mathematical problem-solving skills because of their ability to blend interactive exercises with multimedia explanations (Yohannes, Chen, & Chang, 2023). This is one of the main goals of the general education curriculum and a crucial 21st-century skill (Carlgren, 2013; Kennedy & Sundberg, 2025).

Current research tends to emphasize learning interest (Lai, Hsieh, & Hsu, 2023) self-directed learning (Tran & Nguyen, 2020) or focus primarily on university students (Alshehri, 2024) despite the fact that there is ample evidence supporting the role of interactive electronic textbooks in supporting math learning (Wijaya, Cao, & Li, 2025; Yorganci, 2022). Self-control, persistence, and focus are qualities students often struggle with in elementary school. Limited research has been conducted on how these skills impact students' academic growth and problem-solving abilities (Torrington, Bower, & Burns, 2024). This highlights the need for empirical studies to determine if and how interactive electronic textbooks can support younger students.

Because not much research had been done on the subject, a study was conducted to see how interactive electronic textbooks affected the growth of primary school students' academic problem-solving skills. The study examined whether adding interactive features like math applets, real-world examples, and quick feedback to eTextbooks helped improve students' academic performance, motivation, and problem-solving skills.

The study asks the following questions about this:

Question 1: Does using interactive electronic textbooks help elementary students become more proficient at solving mathematical problems?

Question 2: Does the usage of interactive electronic textbooks impact the learning outcomes, specifically arithmetic proficiency, of elementary students?

Question 3: Do primary students' enthusiasm and interest in learning mathematics change as a result of using interactive electronic textbooks?

## 2. Literature Review

### 2.1. Interactive Electronic Textbooks

Interactive electronic textbooks are a very promising medium for teaching mathematics in primary schools due to the rapid growth of digital learning ecosystems powered by computers, cloud platforms, and artificial intelligence (Chen, Jamiat, Abdul Rabu, & Mao, 2024; Tlili et al., 2024). Unlike printed textbooks, interactive electronic textbooks enable multimodal presentation via audio, video, animation, applets, and real-time feedback. Numerous studies demonstrate how these multimodal features can improve learners' conceptual understanding, cognitive engagement, and attention span, all of which are crucial for children who primarily rely on highly guided, visual representations (Tsuei, Cheng, & Huang, 2020; Wu, Jiang, Long, & Zhang, 2024).

Despite the fact that prior research has repeatedly demonstrated the advantages of electronic textbooks, including enhanced motivation, decreased learning anxiety, and better reading comprehension (Chen & Tsai, 2025; Lee, Chen, & Cheng, 2024; Yohannes et al., 2023). While some researchers show improvements in conceptual understanding or learning outcomes (Rzyankina, George, & Simpson, 2024; Sigarchian et al., 2018), others stress that interactive electronic textbooks primarily influence learning motivation (Lee et al., 2024; Yorganci, 2022). These variations imply that the integration of pedagogically interactive components, rather than the technology itself, is a major factor in the efficacy of electronic textbooks.

According to recent research, well-designed electronic textbooks in mathematics education can help students do more than just practice calculations; they can boost participation, foster mathematical thinking and reasoning, and boost confidence (Chen et al., 2024; Huff & Tseng, 2025; Li, Zhang, & Lu, 2024). However, most of these studies have been carried out at the secondary or tertiary level or have focused on a narrow range of content (for example, arithmetic or basic geometry) (Alshehri, 2024; Tlili et al., 2024). Evidence on how electronic textbooks affect young learners' problem-solving processes remains limited, especially in developing countries.

This gap is particularly noticeable in Vietnam. Although digital transformation in education is advancing quickly, there are still very few experimental studies assessing the impact of electronic textbooks on primary students' achievement and problem-solving skills. Using evidence from real classrooms in Vietnam, this study adds to earlier research by exploring how interactive electronic textbooks impact early mathematics achievement and problem-solving skills.

## *2.2. The Role of Interactive Electronic Textbooks in Mathematics Learning Achievement*

Mathematics achievement usually includes the ability to take in new knowledge, mastery of procedures, and carrying out tasks accurately (Stelzer et al., 2024). According to reviews of earlier research, using digital technology in math lessons, especially interactive materials, can make a significant difference in students' performance by making concepts easier to understand and reducing their cognitive load (Hidayat & Chao, 2025). Technology-based images are great for helping young kids move from hands-on experiences to more abstract thinking, since they often have trouble with abstract ideas (Tarnig, Huang, & Ou, 2024).

Mayer (2024) says that information is handled better when words and pictures are used together. This theory helps explain how well people learn math. Research shows that using multimedia-enhanced electronic textbooks can help students understand concepts better and remember them longer (Gu et al., 2015; Shamir, Segal-Drori, & Goren, 2018). This is done by using ideas like dual channels, coherence, and quick feedback. But some studies show that digital tools that are made incorrectly can distract or hurt the thinking skills of elementary school kids (Shalgimbekova, Ereemeeva, & Pronkin, 2024). These different results show how important it is to carefully plan multimedia and not overload students with unnecessary technical details.

The current study builds on these findings. It uses electronic textbooks for the intervention that have carefully planned visual aids, fewer distractions, and quick feedback. This design aims to examine the processes that help primary school students focus and visualize topics in earlier research to see how these traits affect their math success.

## *2.3. Problem-Solving Capacity and Support of Interactive Electronic Textbooks*

As a key ability of education in the twenty-first century, problem-solving is one of the primary goals of teaching mathematics (OECD, 2018). Polya's (1945) fundamental theoretical framework for problem solving consists of four processes: comprehending the problem, developing a strategy, carrying out the plan, and evaluating the solution. This is a challenging process that requires metacognitive awareness, flexible thinking, and iterative reasoning skills that young students often struggle to develop without proper support.

One possible method to assist with this process is interactive electronic textbooks. Several studies demonstrate that providing mathematical problems with relevant contexts, contextualized simulations, and real-world situations integrated into digital textbooks can enhance students' analytical abilities (Jácome-Guerrero et al., 2024; Mufliva, Herman, Suganda M, Parwines, & Rahmani, 2025). Additionally, immediate feedback helps students self-monitor and select appropriate strategies, which is essential in developing problem-solving competence (Cáceres, Nussbaum, González, & Gardulski, 2021). Game-based elements in electronic textbooks have also been shown to help students boost their persistence and reduce frustration when facing complex tasks (Wang, 2020).

However, despite many positive findings, most previous studies have focused only on procedural outcomes or motivational aspects. They rarely examined how different interactive features in electronic textbooks work together to support the entire problem-solving process. There is also still little research in primary schools in Southeast Asia, where teaching conditions and access to technology are quite different from those in Western countries.

Therefore, in this study, interactive applets, real-life math problems, and instant feedback are integrated into the electronic textbook's design to see how these features work together and how they help improve primary students' problem-solving skills.

## **3. Research Method**

### *3.1. Research Design*

This study adopted a quasi-experimental design with mixed methods triangulation to examine the impact of interactive electronic textbooks on Grade 1 students' mathematics achievement and problem-solving competence. The experimental group learned with an interactive electronic textbook incorporating virtual manipulation, applets, real-time feedback, and guided discovery activities. A conventional printed mathematics textbook with the identical curricular material was utilized by the control group.

Students investigated mathematical ideas through digital interactions, contextual task completion, and instant feedback tailored to their answers in this constructivist instructional design. Teachers used the interactive electronic textbooks both in classroom instruction and as a recommended resource for home learning.

To ensure intervention fidelity, three procedures were implemented:

- (1) Identical teaching time: Both groups received the same number of lessons (8 lessons over 4 weeks), taught in the same time slots on the school timetable.
- (2) Teacher consistency: The same Grade 1 teacher delivered lessons to both groups to eliminate teacher effect bias.
- (3) Monitoring electronic textbooks use: The research team conducted two fidelity checklists per week to verify consistent use of interactive elements across all lessons; tablet logs were also reviewed to ensure that students accessed the intended modules only.

This design is consistent with previous studies on the impact of interactive electronic textbooks on math learning achievement. Electronic textbooks are designed with the goal of constructive teaching, organizing discovery activities. Students can interact with objects in a virtual environment, solve problematic situations, and thereby acquire new knowledge. Feedback interactions are designed to suit each learning operation and individual learners. Teachers use this textbook in classroom teaching and instruct students to use it when learning at home.

### 3.2. Research Subjects and Samples

Participants included 60 Grade 1 students from two classes with equivalent prior achievement at Quang Minh B Primary School, Me Linh District, Hanoi, Vietnam. The study involved minimal risk and adhered to ethical guidelines for research with children. Ethical approval was granted by the Vietnam Association of Psychology and Education, and informed verbal consent was obtained from school administrators, teachers, and the parents of all participating students. All data were anonymized to ensure confidentiality and protect the identities of participants. This sample size aligns with recommendations for experimental studies in primary mathematics education (Besekar, Jogdand, & Naqvi, 2023). The two intact classes were randomly assigned to the experimental group (n = 30) and the control group (n = 30). Balance in gender, baseline mathematics performance, and learning conditions was verified statistically through pre-test comparison ( $p > 0.05$ ).

### 3.3. Measurement Tools

To assess the impact of using interactive electronic textbooks on the academic achievement of Mathematics and problem-solving abilities of grade 1 students, the study used measurement tools designed in accordance with the psychological characteristics of the age group. Specifically, including:

- (1) Mathematics academic achievement test.
- (2) Problem-solving ability assessment.
- (3) Semi-structured student interviews.
- (4) Observation sheet of learning activities during the experiment.

#### 3.3.1. Mathematics Academic Achievement Test

Purpose: To assess the progress of grade 1 students in acquiring and applying Mathematics knowledge after learning with an interactive electronic textbook.

Test Structure: Pre-test: 10 simple questions on measuring, counting, comparing lengths, and recognizing basic shapes, designed as color illustrations. Post-test: 10 similar questions with expanded content, integrating real situations students have experienced in interactive electronic textbooks (e.g., measuring a pencil's length, comparing classmates' heights).

Presentation format: Questions are designed as visual quizzes or correct image selections, avoiding lengthy reading comprehension tasks unsuitable for grade 1 students. Scoring: Each correct answer earns 1 point, with a maximum total score of 10.

**Table 1.** KR-20 reliability coefficient for the mathematics achievement test.

Test component	Number of items	Sample size (n)	KR-20 coefficient	Reliability level
Pre-test (Mathematics achievement)	10	60	0.81	High reliability
Post-test (Mathematics achievement)	10	60	0.84	High reliability

Table 1 presents the KR-20 reliability coefficients of the mathematics achievement test administered as both pre-test and post-test indicate high internal consistency, with KR-20 values of 0.81 for the pre-test and 0.84 for the post-test, suggesting that the instrument is reliable for measuring students' mathematics achievement.

#### 3.3.2. Problem-Solving Ability Assessment

Purpose: To assess the ability of grade 1 students to recognize, choose strategies, and perform simple math problem-solving in familiar situations.

Structure: Includes five learning situations with illustrations, such as: "Mr. An has two pens, Mr. Binh has three pens. Who has more?" Nam has three candies, and his mother gives him four more candies. Ask Nam how many candies he has." Scoring: 0 points: Not answering or answering incorrectly; 1 point: Answering correctly but not clearly stating the reason; 2 points: Answering correctly with a reasonable explanation. The pilot study yielded a Spearman correlation coefficient of  $\rho = 0.91$ , indicating high agreement, while the main study achieved an even stronger reliability coefficient of  $\rho = 0.94$ , demonstrating excellent consistency in scoring across evaluators.

#### 3.3.3. Semi-Structured Student Interviews

Due to the limited ability of Grade 1 students to express themselves in writing, semi-structured interviews were used to collect qualitative data on students' cognitive, emotional, and learning experiences after learning with interactive electronic textbooks. For example, "Do you like learning Math with interactive electronic textbooks? Why?" and "When studying with electronic textbooks, what do you see as different from paper books?"

Recording and processing: Interviews are recorded and coded by topic (conceptual understanding, problem-solving strategies, positive learning attitudes) for thematic analysis.

#### 3.3.4. Observation Sheet of Learning Activities

The learning activity observation checklist was employed to systematically document students' engagement and observable behaviors during mathematics lessons using interactive electronic textbooks. The instrument consisted of eight behavioral criteria, each rated on a three-point scale (1 = minimal participation, 2 = moderate participation, 3 = active participation). Typical indicators included the ability to select appropriate digital activities, manipulate virtual objects, collaborate with peers, and express enjoyment or sustained attention during learning tasks.

To ensure dependability, two separate observers, the researcher and the classroom teacher, recorded student behavior throughout the session. Inter-rater consistency was maintained through collaborative calibration sessions prior to data collection. The internal reliability of the checklist demonstrated good consistency and measurement across settings, with Cronbach's alpha values of 0.87 in the main study and 0.82 in the pilot research.

**Table 2.** Reliability of the learning activity observation checklist.

Measurement phase	Cronbach's alpha	Interpretation
Pilot study	0.82	Good
Main study	0.87	Very good

**Note:** Reliability values above 0.80 indicate strong internal consistency suitable for classroom-based behavioral measurement.

Table 2 presents the reliability results of the learning activity observation checklist show Cronbach's alpha coefficients of 0.82 in the pilot study and 0.87 in the main study, indicating good to very good internal consistency. This suggests that the instrument is reliable and suitable for classroom-based behavioral measurement.

### 3.3.5. Testing The Reliability and Value of the Tool

Content value: Evaluated by three primary education experts, including one Mathematics pedagogical lecturer and two Grade 1 teachers with teaching experience.

Structural value: Accreditation is conducted through correlation analysis between academic achievement scores and problem-solving ability scores.

Uniform values: Comparison of interview results and observations to confirm similarity trends in students' attitudes and learning behaviors.

**Table 3.** Measurement tool summary.

Measurement components	Number of items	Form	Evaluation objectives	Expected reliability
Math academic achievement test	10 Questions	Picture quiz	Math learning outcomes	KR-20 $\geq$ 0.8
Problem-solving capacity	5 Scenarios	Image – open-ended questions	Cognition and logical thinking	$\rho \geq$ 0.9
Semi-structured interviews	5 Questions	Direct – qualitative	Knowledge, attitude, problem-solving	-
Academic observation sheet	8 Criteria	3-level month	Active behavior and participation	$\alpha \geq$ 0.8

Table 3 presents a summary of the measurement tools used in this study, including their components, formats, evaluation objectives, and expected reliability. The math academic achievement test consists of 10 picture-based questions designed to assess students' learning outcomes, with an expected reliability of KR-20  $\geq$  0.8. Problem-solving capacity is measured through five image-based, open-ended scenarios targeting cognition and logical thinking, with a high expected reliability ( $\rho \geq$  0.9). Semi-structured interviews are employed to explore students' knowledge, attitudes, and problem-solving approaches, while classroom behaviors and participation are captured using an academic observation sheet comprising eight criteria, with an expected reliability of  $\alpha \geq$  0.8.

## 3.4. Data Collection and Processing Process

### 3.4.1. Data Collection Process

The research was carried out in a quasi-experimental design with two groups of grade 1 students with equivalent qualifications.

Experimental group (n=30): learning using an interactive electronic textbook with integrated manipulation activities, learning games, and automatic feedback.

Control group (n=30): learning using traditional printed textbooks, taught with the same content, with the same teacher, and in the same time period.

The data collection process proceeds through four stages.

Stage 1: Preparation

Develop and complete interactive electronic textbooks with learning activities in accordance with the Grade 1 Mathematics program.

Design a set of measurement tools (Tests, observation sheets, scales, interviews).

Conduct a pilot test on a group of 10 students to check the clarity of the questions and the relevance of language and images.

Calibrate the tool based on feedback and expert opinions.

Stage 2: Pre-test

Both groups of students took a pre-experimental math achievement test to determine their initial level of knowledge.

The questions are instructed by the teacher to read aloud, ensuring that students understand the content correctly.

The pre-test results were used to compare the initial similarity between the two groups.

Stage 3: Conducting experiments

The experiment was held for 4 weeks (8 lessons), according to the same content, "Measuring length and comparing quantities".

Students in experimental groups use interactive electronic textbooks, where they work directly on tablets, play educational games, see visual simulations, and receive immediate feedback.

The control group used standard teaching methods and traditional paper books for their studies.

Teachers and researchers record the learning activity observation sheet during the process to gauge the degree of student engagement and learning behavior.

Stage 4: Post-experimental data collection

After the lesson ended, both groups finished a post-test that was formatted similarly to the pre-test.

In order to understand more about their learning preferences, feelings, and methods for solving problems when using electronic textbooks, ten students from the experimental group participated in semi-structured interviews.

All data is collected, validated, encoded, and fed into statistical processing tools for analysis.

3.4.2. Data Processing Process

The data obtained includes both quantitative and qualitative data, which are processed in two parallel directions:

(1) Quantitative data

Data sources: pre-test, post-test, and observation sheets.

Step 1: Input data into SPSS 26.0 software for descriptive statistical analysis (Mean, SD).

Step 2: Independent t-test to compare the average score between the experimental group and the control group before and after the experiment.

Step 3: Dependent t-test testing in each group to determine post-intervention progress.

Step 4: Calculate the Gain Score and Effect Size (Cohen's d) to assess the impact of using electronic textbooks.

(2) Qualitative data

Data sources: student interviews and teacher observation notes.

Step 1: Transcribe the interviews and code them by topic (Coding).

Step 2: Content analysis according to three main themes:

Changes in the understanding of Mathematical concepts.

How to solve problems and arguments of students.

Attitude and interest in learning with electronic textbooks.

Step 3: Combine qualitative data with quantitative data to comprehensively interpret the intervention effectiveness.

3.4.3. Ensuring the Reliability and Value of Data

Intrinsic reliability: Tested by Cronbach's alpha coefficient, KR-20, and dot correlation.

Content value: Appraised by experts on the suitability of the measuring tool for grade 1 age.

External value: Ensure through the selection of a sample of students from two classes with similar learning conditions, and the teacher teaches.

Objectivity: The data was collected by two independent people (the class teacher and the researcher), in order to limit subjective bias.

Table 4. Implementation procedure.

Stage	Main Activities	Purpose	Tools used
1. Preparation	Build electronic textbooks, measurement tools, and pilot tests	Ensure tool reliability	Draft electronic textbooks, a set of test questions
2. Pre-test	Test your initial knowledge	Determining the equivalence between the two groups	Previous Math Tests
3. Experiment	Organizing teaching with electronic textbooks and paper textbooks	Intervention and observation of learning behavior	electronic textbooks, observation sheets
4. Post-test & interview	Testing, interviewing, and data synthesis	Assessment of Learning Outcomes and Student Feedback	Post-test, interview, SPSS 26.0

Table 4 presents the four-stage implementation procedure of the study, including preparation, pre-test, experiment, post-test, and interview.

4. Results

4.1. Quantitative Results

4.1.1. Comparison of Pre-Test Results Between Two Groups

To ensure initial equivalence between the experimental and control groups, the Pre-test scores were analyzed using the Independent Samples t-test.

Table 5. Comparison of Pre-Test mathematics achievement scores between experimental and control groups.

Group	N	Mean	SD	t	Sig. (2-tailed)
Experimental	30	5.03	1.12	0.417	0.678
Controls	30	4.91	1.09		

Table 5 presents the comparison of pre-test mathematics achievement scores between the experimental and control groups shows that the experimental group's mean score (M = 5.03, SD = 1.12) is slightly higher than the control group's (M = 4.91, SD = 1.09). The independent-samples t-test indicates no statistically significant difference (t = 0.417, p = 0.678 > 0.05). These findings suggest that both groups are comparable in prior mathematics achievement before implementing electronic textbooks.

4.1.2. Comparison of Post-Test Results Between the Two Groups

After the experimental process (4 weeks), both groups were retested with a post-test.

**Table 6.** Comparison of Post-Test mathematics achievement scores between experimental and control groups.

Group	N	Mean	SD	t	Sig. (2-tailed)	Cohen's d
Experimental	30	8.43	0.98	4.92	p < 0.001	1.26
Controls	30	6.97	1.13			

Table 6 presents the comparison of post-test mathematics achievement scores between the experimental and control groups shows that students in the experimental group achieved a higher mean score ( $M = 8.43$ ,  $SD = 0.98$ ) than those in the control group ( $M = 6.97$ ,  $SD = 1.13$ ). The independent-samples t-test indicates a statistically significant difference between the two groups ( $t = 4.92$ ,  $p < 0.001$ ). Furthermore, the effect size is large (Cohen's  $d = 1.26$ ), indicating a strong impact of interactive electronic textbooks on students' mathematics achievement. The data addressing Research Question 2 shows that using interactive electronic textbooks significantly improves grade 1 students' mathematics learning outcomes compared to traditional printed textbooks.

#### 4.1.3. Comparison of Progress in Each Group (Paired T-Test)

Paired Samples t-test analysis was used to assess progress in each group before and after the experiment.

**Table 7.** Pre-Test and Post-Test mathematics achievement scores within each group (Paired Samples t-Test).

Group	Mean (Pre)	Mean (Post)	t	Sig. (2-tailed)	Gain Score
Experimental	5.03	8.43	10.21	p < 0.001	+3.40
Controls	4.91	6.97	8.06	p < 0.001	+2.06

Result: As shown in Table 7, paired samples t-test results indicate that both the experimental and control groups made statistically significant progress from pre-test to post-test ( $p < 0.001$ ). The experimental group showed a larger mean gain of 3.40 points compared to 2.06 points, indicating greater improvement.

This confirms that interactive electronic textbooks create conditions for students to absorb knowledge better, especially in activities involving manipulation and instant feedback.

#### 4.1.4. Results of Problem-Solving Capacity

**Table 8.** Comparison of problem-solving capacity between experimental and control groups.

Group	N	Mean	SD	t	Sig. (2-tailed)	Cohen's d
Experimental	30	8.13	1.04	4.45	p < 0.001	0.99
Controls	30	6.87	1.15			

Table 8 presents the comparison of problem-solving capacity between the experimental and control groups. The results show that the experimental group achieves a higher mean score ( $M = 8.13$ ,  $SD = 1.04$ ) than the control group ( $M = 6.87$ ,  $SD = 1.15$ ). The independent-samples t-test indicates a statistically significant difference between the two groups ( $t = 4.45$ ,  $p < 0.001$ ). The effect size is large (Cohen's  $d = 0.99$ ), suggesting a substantial impact of interactive electronic textbooks on students' problem-solving capacity. These findings suggest that students in the experimental group demonstrate greater flexibility in thinking, more appropriate selection of problem-solving strategies, and improved self-monitoring and error-checking skills. From the data answering Research Question 1, the interactive electronic textbooks group exhibited more flexible thinking, more appropriate selection of problem-solving strategies, and better self-detection and checking of errors.

#### 4.1.5. Correlation Between Academic Achievement and Problem-Solving Ability

**Table 9.** Correlation between mathematics academic achievement and problem-solving competence.

Variables	r	Sig. (2-tailed)
Correlation between academic achievement and problem-solving competence.	0.724	0.000***

Note: \*\*\*  $p < 0.001$  (two-tailed).

Result: As shown in Table 9, there was a strong positive correlation between mathematics academic achievement and problem-solving competence ( $r = 0.724$ ,  $p < 0.001$ ), indicating that students with higher problem-solving skills tend to score higher in mathematics.

Students with high problem-solving abilities often perform better in math, demonstrating the positive impact of electronic textbooks on thinking development and parallel learning outcomes.

#### 4.2. Qualitative Results

Qualitative data were collected from semi-structured interviews with 10 experimental group students and observation sheets during lessons.

(1) Interview the student

The analysis shows:

80% of students said that learning with interactive electronic textbooks is more fun because of the animations, sounds, and games.

70% of students affirmed that it is easier to understand and that they remember it longer because they have watched and redone it many times.

Some students demonstrate the ability to detect errors on their own and try again, a characteristic manifestation of problem-solving ability.

Typical speech examples: "When I miscalculated, the screen reported me wrong, so I thought again and gave a different answer." This proves that the immediate feedback mechanism in electronic textbooks helps reinforce the trial-and-error mindset.

(2) Observe learning activities

Teachers and researchers note: Students in the experimental group were more focused and active in manipulating ( $M = 2.8/3$  compared to  $2.1/3$  in the control group).

Students often collaborate and discuss when doing learning games on electronic textbooks.

Particularly when sound, animation, or virtual prizes are included, the classroom environment is vibrant and upbeat.

According to the qualitative study addressing Research Question 3, electronic textbooks increased motivation, engagement, and teamwork in Grade 1 mathematics, in addition to improving learning results.

## 5. Discussion

According to the study, first graders learn math much better when they use interactive computer guides. The kids that were part of the experimental group did better on two tests that were meant to measure academic success and problem-solving skills than the kids that were part of the control group. Students in the testing group showed more interest in the subject, took more responsibility, and worked together better. This shows that technology can help kids remember things, study, and think positively.

The findings of this study concur with those of earlier investigations, including Hoch, Reinhold, Werner, Richter-Gebert, and Reiss (2018); Rezat (2021); Siano and Potane (2021), and Chang and Chen (2024). These studies show that students' general learning and comprehension of arithmetic are enhanced by interactive e-textbooks with multimedia, fast feedback, and interactivity. Well-designed mobile texts increase students' interest in and confidence in their mathematical abilities (Turel & Sanal, 2018). According to our research, students who use accessible electronic textbooks are more adept at solving problems, maintaining an open mind, and identifying and correcting errors. The same was discovered in 2024 by Lee et al. (2024). These new findings support and supplement previous research using interactive computer textbooks with first-graders. Although they are adept at observing visual clues and direct feedback, this group struggles to think about abstract concepts.

The benefits of interactive electronic textbooks are demonstrated by the theories underlying modern education. According to Mayer (2004), integrating text, images, sounds, and interactive exercises that employ both hearing and sight simultaneously reduces cognitive load and lengthens memory. The constructivist theory of Vygotsky (1978) demonstrates the significance of student participation and feedback during the learning process (Çibukçiu, 2025). This enables pupils to learn by doing and then modify their tactics in response to what they discover. Teaching math to primary school students involves using math rules to create lessons in interesting e-textbooks with entertaining assignments, instructive games, and visual simulations. Students learn most effectively when they engage with others and receive feedback, according to Vygotsky's constructivist theory from 1978. Doing things incorrectly, then correcting them and changing for the future, helps kids learn more. These concepts can be used in basic arithmetic instruction when employing interactive electronic textbooks with interactive exercises, educational games, and visual simulations.

Younger people's education is greatly impacted by interactive electronic texts since they make learning more engaging and enjoyable (Chang & Chen, 2024). Students reported that math lectures were "more enjoyable," "easier to comprehend," and "more memorable" after using interactive electronic textbooks that included games, music, and animations. The findings of Sun and Hsieh (2018) about the ability of interactive learning aids to increase motivation and attentiveness are consistent with this. Active learners who receive prompt feedback gain new skills and improve their problem-solving abilities through experimentation, consequence analysis, and strategy modification.

Elementary school pupils can learn effectively from electronic textbooks that they can interact with, according to Sigarchian et al. (2018) and Shalgimbekova et al. (2024). In addition to aiding children in learning and remembering numbers, this tool promotes self-control, critical thinking, and problem-solving skills. These components are all crucial for teaching math in the twenty-first century. Studies demonstrating the use of interactive e-textbooks in early primary school are crucial for developing digital learning aids, as more education is conducted online. This supports new ideas in education even more.

### 5.1. Theoretical Meaning

The study endorses constructivist learning paradigms by demonstrating that digital technology facilitates knowledge acquisition through experience and engagement. The research further elucidates the relationship between digital learning environments and problem-solving abilities. This is crucial for 21st-century education.

### 5.2. Practical Effects

The findings indicate that interactive electronic textbooks must be utilized in elementary mathematics schools to enhance learning and problem-solving abilities. Learning material designers should focus on creating interesting activities that facilitate learning through diverse methodologies, ensuring the activities are pertinent to real-world issues, and providing immediate feedback. Due to digital transformation, educational management organizations must establish regulations that support technological systems, instruct educators, and promote the use of interactive electronic textbooks among elementary school pupils.

This study demonstrates that interactive electronic textbooks are effective for enhancing mathematical learning and problem-solving abilities. It also provides significant insights into implementing reforms in fundamental education in Vietnam.

## 6. Conclusion

The effectiveness of interactive electronic textbooks in improving primary school students' mathematical and problem-solving skills was investigated. First graders participated in a quasi-experimental study, and the findings demonstrated that students who used interactive electronic textbooks outperformed the control group on post-tests and had a large effect size. Along with their academic progress, children showed greater self-correction behaviors, increased motivation, and a broader range of problem-solving strategies.

Additionally, when students encountered challenging assignments, the qualitative data demonstrated that touch-based interaction, real-time feedback, and multimedia components encouraged deeper conceptual understanding, increased engagement, and improved perseverance. According to these findings, focused digital interaction can encourage active knowledge construction in early mathematics education, which aligns with socioconstructivist theory and multimedia learning principles.

All things considered, the study provides empirical support for the educational advantages of using interactive electronic textbooks to teach primary mathematics. The findings demonstrate the importance of well-planned digital learning materials that include perceptive interaction and feedback. Educational leaders, educators, and curriculum designers are urged to employ interactive electronic textbooks as part of broader efforts to enhance learning experiences and develop crucial problem-solving abilities in the early grades.

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