

A Systematic Literature Review: The Role of Digital Technology in Improving Conceptual Understanding and Problem-Solving Skills

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Abstract

In response to the evolving demands of 21st-century education, particularly the critical need to enhance students' conceptual understanding and problem-solving skills in mathematics, the strategic integration of digital technology has become increasingly vital. This research aims to explore the role of digital technology in improving students' conceptual understanding and problem-solving skills by classifying the types of tools used in previous studies. The method employed is a Systematic Literature Review (SLR). Data were sourced from the Google Scholar database, collected, filtered, and synthesized to form an article. The results of this study indicate that digital technology plays a significant role in students' conceptual understanding and problem-solving abilities in mathematics. The digital tools and products used to enhance students' conceptual understanding in mathematics include Microsoft Teams, Microsoft Form, Nearpod, Kahoot, Construct 2, Geoshape, Miro, Teams Room, Google Docs, Quizizz, Wordwall, FlipPDF, Patt_Art, digital LKPD (Learning Activity Sheets), Digital Games-Based Learning (DGBL), and learning materials based on Internet Technology. Meanwhile, the tools and digital products used to improve students' problem-solving skills in mathematics include Liveworksheet, GeoGebra, Spreadsheet, Schoology, Edmodo, Cloud Technology (Google Docs, Google Slides, Google Drive, Google Meet, Google Classroom, and SlideShare), Desmos, Padlet, digital book media, digital LKPD, and digital games. Future research could explore more effective teaching strategies in utilizing digital technology, ensuring that it not only enhances conceptual understanding and problem-solving skills but also fosters students' independent learning.

Keywords: digital technology, conceptual understanding, problem-solving

Introduction

Education is essentially a conscious human effort to change a person's circumstances by increasing knowledge or gaining learning experiences based on the values of the educational process. Through education, individuals acquire knowledge that can serve as a guide for adapting to the development of life towards a sustainable modernization. In education, learning is a vital component of every educational process. Learning outcomes are generally considered a benchmark for students' success in achieving their educational objectives.

The Indonesian Partnership for 21 Century Skill Standard (IP-21CSS) directs the implementation of education to be oriented toward 21st-century skills, with one sub-component currently receiving significant attention in the field of education being problem-solving skills. The importance of problem-solving skills is emphasized by the National Council of Teachers of Mathematics as both a learning objective and an

instructional approach (Takahashi, 2021). An individual's ability to address problems may vary. Goldstein and Levin (in Zulkarnain & Budiman, 2019) classify mathematical problem-solving skills as high-level cognitive processes that require more complex controls and modulation compared to routine skills. In the context of mathematics learning, finding solutions to problems requires specific strategies to achieve intended outcomes. Zulkarnain & Budiman's (2019) research found that students' mathematical problem-solving skills are influenced by students' conceptual understanding. These two abilities are positively correlated, meaning that if the goal of mathematical learning is to improve students' problem-solving skills, improving their conceptual understanding is also essential. Sengkey et al. (2023) define conceptual understanding as the ability to process and interpret acquired information into meaningful knowledge. Furthermore, the strength of a concept is also derived from a student's ability to integrate and relate diverse experiences. The more abstract the concept, the greater this capacity becomes (Skemp, 1987), which is particularly evident in advanced mathematical topics where abstract reasoning is paramount.

In the current era of digitalization, the role of technology is crucial in improving students' abilities, particularly in problem-solving and conceptual understanding. The integration of technology into learning is implemented through the use of technology-based media and instructional materials, serving as informational tools to support the learning process. Various forms of technology have emerged in the field of education, including applications, websites, videos, animations, augmented reality (AR), virtual reality (VR), and others. Technological advancement is a consequence of scientific development and has a significant impact on the implementation of mathematics instruction. As discipline considered precise and foundational to mastering other fields of science, mathematics is regarded as one of the most relevant subjects for adapting to technological progress. The ability to grasp mathematical concepts is also closely related to students' problem-solving skills (Desryanto, 2023). With a strong conceptual understanding in mathematics, students are expected to solve problems involving the application of those concepts, especially with the aid of technology.

Several research studies have explored the role of digital technology in improving problem-solving skills and conceptual understanding. For instance, Qudwatullathifah et al. (2023) found that the Liveworksheet digital platform significantly enhanced elementary students' mathematical problem-solving abilities. Similarly, Chimmalee and Anupan (2022)

demonstrated that Cloud Technology improved undergraduate students' mathematical problem-solving competence. In the context of conceptual understanding, Hariyono and Widhi (2021) showed that the 'Geoshapes Digital' learning media effectively increased students' conceptual understanding in mathematics at the elementary level. While these studies, and many others, highlight the individual benefits of specific digital tools on either mathematical conceptual understanding or problem-solving skills, there remains a lack of a comprehensive synthesis that systematically reviews and categorizes the diverse range of digital technologies applied to simultaneously foster both these crucial mathematical abilities. Existing literature reviews tend to be less exhaustive in classifying the specific types of digital tools and their dual applicability. Therefore, to address this gap, this study presents a Systematic Literature Review (SLR) on the role of technology in supporting conceptual understanding and problem-solving among students, with a particular focus on digital mathematical tools developed by previous researchers. It is expected that the findings of this review can serve as a reference for the further development of digital technology in mathematics education, particularly in efforts to improve students' conceptual understanding and problem-solving skills.

Method

This article utilizes the Systematic Literature Review (SLR) method with a qualitative descriptive approach. A Systematic Literature Review involves a rigorous and transparent process of identifying, evaluating, and synthesizing all relevant research studies pertaining to a specific topic or research question (Booth et al., 2022).

The aim of this research is to provide a comprehensive review of the role of digital technology in improving conceptual understanding and problem-solving skills. This study follows PRISMA (Preferred Reporting Items for Systematic Review and Meta-analysis) framework, which involves several key stages: establishing inclusion and exclusion criteria, identifying relevant electronic databases, selecting and collecting articles, and filtering data for analysis (Prill et al., 2021).

1. Inclusive and Exclusive Criteria

The inclusive and exclusive criteria in this study are as follows:

Inclusive Criteria

- 1) IC1: Published between 2018 – 2024
- 2) IC2: About the role of digital technology in improving conceptual

understanding and problem-solving skills

3) IC3: Written in English or Indonesian

4) IC4: Open access

Exclusive Criteria

1) IC1: Duplicate articles

2) IC2: Outside of Mathematics Education

3) IC3: Written in addition to Indonesian and English

4) IC4: Close access

2. Elektronik Database

Relevant articles are searched by keywords “teknologi, pemahaman konsep matematika”, “digital, pemahaman konsep matematika”, “technology, mathematical concepts”, “digital, mathematical concepts”, “teknologi, pemecahan masalah matematika”, “digital, pemecahan masalah matematika”, “technology, mathematical problem solving”, “digital, mathematical problem solving” accompanied by a restriction on the year of publication between 2018 – 2024 through the Google Scholar reference search engine with keyword criteria stated in the article title. At this stage, a total of 87 related search results were obtained.

3. Article Selection

The selection of articles based on keywords, inclusion criteria, and separating articles that fall into the exclusion criteria. Articles were screened by reviewing their titles, abstracts, discussions, and conclusions. At this stage, a total of 35 articles were obtained.

4. Collecting Articles

The selected articles were then reviewed in greater detail. The final article obtained was about the role of digital technology in improving conceptual understanding and problem solving with a total number of 31 articles.

5. Filter Data

After the articles were obtained, the data were analyzed to add the research questions concerning the role of digital technology in improving conceptual understanding and problem-solving skills.

Results and Discussion

The use of digital technology in mathematics learning plays a crucial role in improving students' conceptual understanding and mathematical problem-solving. Based on previous studies, the use of digital technology is highly recommended. The following section presents a summary of research studies related to the use of digital tools in supporting conceptual understanding and mathematical problem solving.

Tabel 1. List of used articles

No	Reference	Title	The Digital Technology Used	Research Findings
1	Bruce et al.	Developing an effective technology based delivery model that adds value to learning and supports learners to develop a growth mindset to enable them to gain insights into mathematical concepts	Microsoft Teams, Microsoft Form, and Nearpod	Microsoft Team and Microsoft forms do not really support mathematics learning so it is better to combine them with tools that support mathematics learning, one of which is Nearpod. The results of this study indicate that the combination of using Microsoft Team and Microsoft forms with Nearpod is more interactive and provides easier opportunities for collaboration between students.
2	Rohmah. (2020)	The Effectiveness Of Patt_Art Media Based On Digital Literation In Introducing athematical Concepts For Early Ages	Part_Art	Part_Art media is more effective than conventional media.
3	Qudwatullathifah et al. (2023)	The Effectiveness of Digital-Based Mathematics Learning Platforms to Improve Elementary School Students' Problem-Solving Skills	Liveworksheet	The use of digital platforms in the form of liveworksheets can improve students' problem-solving abilities in mathematics learning.
4	Rosida et al. (2019)	An Analysis of Mathematical Problem-	No specific type of technology is	Good use of digital technology will have an impact on improving

No	Reference	Title	The Digital Technology Used	Research Findings
		Solving Based on Students' Use of Digital Technology	mentioned	problem-solving abilities.
5	Anwar et al. (2024)	Exploring the Characteristics of Digital Pedagogy Model for Developing Computational Thinking in Mathematical Problem Solving	Geogebra	The results of CT showed that direct CT activities were more effective than digital CT activities in solving mathematical problems.
6	Jacinto. (2023)	Engaging Students in Mathematical Problem Solving with Technology during a Pandemic: The Case of the Tecn @MatClub	Geogebra, Spreadsheet	The main results show that after-school face-to-face mathematics activities can be adapted to an online format, allowing secondary students to engage in mathematical problem solving with technology. This is done by providing appropriate mathematical challenges and encouraging collaboration.
7	Dewi et al. (2023)	The Influence of Technology Use as a Moderator Between Learning Interest and Numerical Literacy on Mathematical Problem-Solving Ability	Schoology	<ol style="list-style-type: none"> 1) Interest in learning does not affect the use of technology 2) Interest in learning does not affect problem solving 3) The use of technology affects problem solving 4) Numeracy literacy affects the use of technology 5) Numeracy literacy affects problem solving 6) Interest in learning does not have a significant effect on problem solving through the use of technology 7) Numeracy literacy has an effect on problem solving through the use of technology.

No	Reference	Title	The Digital Technology Used	Research Findings
8	Misa & Mariani. (2021)	Metacognition ability of grade X students in mathematical problem solving through a digital project-based learning with Edmodo	Edmodo	<ol style="list-style-type: none"> 1) The problem-solving ability of students who have high metacognitive abilities fulfills four problem-solving indicators, 2) The problem-solving ability of students who have moderate metacognitive abilities fulfills three problem-solving indicators, 3) The problem-solving ability of students who have low metacognitive abilities only fulfills two problem-solving indicators.
9	Boru et al. (2024)	Preliminary Research: Development of Digital Student Worksheets Based on Indonesian Realistic Mathematics Education to Improve Deaf Students' Understanding of Mathematical Concepts	Digital LKPD	<ol style="list-style-type: none"> 1. Students at SMPLB N 7 Jakarta have difficulty in integer material. 2. The results of the mathematical concept understanding ability test show that the ability of deaf students in understanding mathematical concepts in integer material is still relatively low.
10	Chimmalee & Anupan. (2022)	Effect of Model-Eliciting Activities using Cloud Technology on the Mathematical Problem-Solving Ability of Undergraduate Students	Google docs, google slide, google drive, google meet, google classroom, and slideshare	The research subjects showed satisfactory competence in applying key mathematical concepts to solve problems when implementing Model-Eliciting Activities using Cloud Technology in Mathematics learning.
11	Muslikasari & Rusnilawati. (2023)	Learning Model of Role Playing with Digital Games on Mathematics Problem-	The type of digital game is not mentioned	Problem-solving attitudes and skills in mathematics learning after using the role playing learning model with digital games

No	Reference	Title	The Digital Technology Used	Research Findings
		Solving Skills and Attitudes		showed better results compared to the cooperative learning model using fraction board media.
12	Buchori et al. (2022)	The Development Digital Book Media with Learning Model Contextual Teaching And Learning to Improve Student Mathematical Economic Problem Solving Skills	Digital Book Media	Digital book media with the Contextual Teaching and Learning (CTL) learning model has been proven to be practical, valid, and effective in improving students' mathematical economic problem-solving skills.
13	Shi. (2022)	Innovating the Instruction of Mathematical Concepts: How Does the Integrated Use of Digital Games and Language-Based Teaching Matter?	No mention of the type of digital game	This paper discusses the potential integration of Systemic Functional Linguistics (SFL) with Digital Game-Based Learning (DGBL) in K-12 mathematics teaching. Specifically, the paper highlights the important role of SFL in enhancing DGBL of mathematical concepts by revealing the relationship between language and content. Examples of teaching practices are also provided for teachers on how to integrate DGBL of mathematical concepts and SFL, and how they can better apply this integrated framework in teaching mathematical concepts.
14	Jacinto & Carreira. (2023)	Knowledge for teaching mathematical problem-solving with technology: An exploratory study of a mathematics teacher's	Geogebra and Spreadsheet	The results of research in this article reveal the complexity of problem solving by experts with technology, through the regulatory process and some micro cycles that mainly involve the process of integration and exploration.

No	Reference	Title	The Digital Technology Used	Research Findings
		proficiency		Solving mathematical problems with technology requires relevant mathematical knowledge, as well as knowledge of the mathematical potential of the available digital tools, and the ability to combine it to develop the conceptual model of the problem solution.
15	Orhani. (2023)	Teaching and Learning Basic Mathematical Concepts Based on Digital Games	No mention of the type of digital game	Digital computer games are very effective in improving student learning and satisfaction with mathematics, especially when students actively think of and assess the mathematical concepts that exist in the game. There are three important factors that help focus students' attention on mathematics: student attitudes, supporting activities, and cooperation in playing.
16	Hendriani & Gusteti. (2021)	The Validity of a Problem-Based Electronic Student Worksheet (LKPD) Integrated with the Character Value of Self-Confidence for Enhancing Elementary Students' Mathematical Problem-Solving Skills in the Digital Era	e-LKPD	E-LKPD Based on Problem Integrated Value of Confidence Character which in the addition material with different denominations can be concluded based on an assessment of aspects of content, language and design is declared valid so that it can be used further to practice the ability to solve students' problems.
17	Santos-Trigo et al. (2021)	Teachers' Use of Technology Affordances to Contextualize and Dynamically Enrich and Extend Mathematical	GeoGebra	The use of technology by teachers helps expand various problem solving strategies, such as using simpler examples, shifting objects regularly, measuring the properties of objects, and finding

No	Reference	Title	The Digital Technology Used	Research Findings
		Problem-Solving Strategies		object positions. These strategies help them in reason and solve problems.
18	Khadijah et al. (2023)	Application of Digital Books through Guided Discovery Learning to Improve Mathematical Problem Solving Ability of Class VIII Students at SMP Swasta Dharma Patra	Digital book	The application of digital books in learning using the Guided Discovery Learning model can improve the ability to solve the mathematical problems of class VIII students in Dharma Patra Private Middle School.
19	Rahma et al. (2022)	The Effect of Project-Based Learning Models Aided by Teaching Materials Through Internet Technology to Improve Analytical and Comprehension Mathematical Concepts Ability	No specific type of technology is mentioned	Improving students' analytical skills and understanding mathematical concepts through the Project-Based Bless Learning Learning Model supported by internet technology teaching materials is better than the ordinary learning models carried out by teachers in schools.
20	Ningrum et al. (2023)	Development of an Interactive Digital Student Worksheet Using a Realistic Mathematics Education (RME) Approach to Enhance Problem-Solving Skills in Social Arithmetic for Grade VII Students	LKPD Digital	The quality of interactive Digital LKPD that has been developed with a realistic mathematical approach to raise problem solving skills in social arithmetic material is sufficiently sufficient categories of validity, practicality, and effectiveness. Learning Outcomes in Student Mathematical Problem Skills Skills presented by learning by applying products get an increase in average from the pretest test to the final ability test (posttest).
21	Rajkumar et al. (2019)	Engage Stakeholders on Capacity Building Development	Web-based graphic calculator,	Innovative focus on Indian startup programs to develop capacity building programs for

No	Reference	Title	The Digital Technology Used	Research Findings
		Programme for Undergraduate Students in Mathematical Problem Solving Competence for Competitive Examination Using Multimedia Technology-An Innovative Focus on Startup India	Desmos	undergraduate students in mathematical problem solving competencies for competitive examinations using multimedia technology will be more useful and involve stakeholders for better development in competitive examinations in India.
22	Albano et al. (2024)	Digital Experiences of Mathematical Cognitive Functions in Learning the Basic Concepts of General Topology	Miro, Teams Room, and Google Docs	Technological organization allows students to be involved in a process that can be called 'reflection in action'. Observers can reflect on how their friends solve problems during the process, but they can also look back at the notes that have been made. That way, observers are also involved in solving problems. In addition, a rich and productive mathematical discussion emerged among students, which involved the use of various symbols and language styles. Technology - based environment seems to be very helpful in supporting this type of interaction.
23	Darma. (2023)	Effect Size Digital Mathematics Textbook in Blended Learning Assisted by Schoology Improves Mathematical Problem Solving Ability for Polytechnic Student	Schoology	The effects of digital mathematics books to improve the ability to solve mathematical problems in learning blended schoology are very large.
24	Bakoban et al.	Development of a	Digital Book	1) Interactive Book Learning

No	Reference	Title	The Digital Technology Used	Research Findings
	(2022)	Digital Textbook as a Learning Medium Using the Realistic Mathematics Education Approach to Improve Problem-Solving Skills of Students at SMPN 13 Medan	(Flip PDF Professional)	Media developed using a realistic mathematics learning approach to rectangular material (square and rectangle) meets valid, practical, and effective criteria for improving student problem solving skills; 2) The ability to solve students' problems using interactive digital book learning media that are developed based on realistic mathematics learning approaches to rectangular material (square and rectangles) experienced an increase from trial I to trial II.
25	Cavalletti et al. (2024)	Mathematical discussion in problem solving activities supported by technology: An achievable goal in primary school	Padlet	Padlet is an effective tool even for younger students and makes it possible to support mathematical discussions and encourage different strategy comparisons in problem solving activities, while encouraging student participation with special needs.
26	Purwadi. (2022)	The Effect of the Realistic Mathematics Education (RME) Approach Assisted by the Digital Learning Media 'Kahoot!' on Students' Understanding of Mathematical Concepts	Kahoot	Understanding the mathematical concepts of students who are taught with the RME approach assisted by digital -based learning media "Kahoot!" Better than understanding mathematical concepts that are taught with conventional learning.
27	Nurmala & Maulina. (2023)	Development of the Android-Based Digital Literacy Media 'LOTIKA' to Enhance	Construct 2	There is an increase in the ability to understand concepts after using Android -based "Lotika" digital literacy media.

No	Reference	Title	The Digital Technology Used	Research Findings
		University Students' Understanding of Mathematical Concepts		
28	Halim & Hadi. (2023)	An Analysis of the Effectiveness of Digital Media Use in Enhancing Mathematical Concept Understanding of Grade VII Students at SMP Negeri 275 Jakarta	The type of digital game is not mentioned	The use of digital media in learning mathematics in class VII students at SMP Negeri 275 Jakarta has a positive impact in increasing the understanding of mathematical concepts.
29	Hariyono & Widhi. (2021)	Geoshape Digital: A Learning Medium to Improve Elementary Students' Understanding of Mathematical Concepts	Geoshape	Digital Geoshapes Media has fulfilled valid and practical criteria as well as buyers with digital geoshapes media can also increase understanding of student concepts shown by the average evaluation test score reaching 76 based on t test calculations.
30	Khasanah et al. (2024)	Utilization of Culturally-Based Digital Media to Improve Students' Literacy and Understanding of Mathematical Concepts	Quizizz, Kahoot!, Wordwall, FlipPDF, Constrak2;	1) Understanding and knowledge of partners related to cultural - based digital media increased by 22%; 2) MGMP teachers in mathematics in Pringsewu Regency are skilled in developing Lampung Culture Integrated Digital Media that are appropriate dan efektif digunakan.
31	Ramadhani et al. (2023)	Development of Interactive Learning Media Based on Information Technology to Improve Grade VII Junior High School Students'	The type of digital game is not mentioned	Development of Interactive Learning Media Based on Information Technology with the design of the Addie Model effectively in increasing the understanding of the mathematical concepts of junior high school

No	Reference	Title	The Digital Technology Used	Research Findings
		Understanding of Mathematical Concepts in Social Arithmetic		students in class VII on social arithmetic material.

Based on the reviewed articles, various types of technological tools and their roles in improving conceptual understanding and solving mathematical problems were identified.

1.1 Conceptual Understanding Skills

Skemp (1987) stated that concepts in learning are difficult to define due to their abstract nature. According to Skemp, a concept is an idea that develops through several stages: classifying, pairing, classifying, then naming. In the initial stage, individuals classify objects based on their experiences. In the next stage, these experiences are grouped or paired into broader categories. The third stage involves classifying based on function, relationships, or similarities. Finally, in the last stage, individuals assign names and definitions to the concepts. In essence, Skemp emphasized that conceptual understanding begins as a natural process in response to new stimuli and is developed through prior experience and background knowledge. This view aligns with Jean Piaget (1952) theory, which regards conceptual understanding as part of cognitive development that occurs through the processes of assimilation and accommodation. Conceptual understanding emerges when individuals assimilate new information into their existing cognitive structures (Schemas) and accommodate those schemas in response to new information. Furthermore, Ausubel (1968) defined conceptual understanding as a process in which new information is meaningfully integrated into an individual's existing knowledge structure. He proposed the theory of meaningful learning, which posits that true conceptual understanding occurs when individuals are able to connect new knowledge to previously understood concepts.

Conceptual understanding plays an important role in the learning process, as it provides a strong foundation for long-term knowledge retention. It enables students to understand the underlying principles of a topic, going beyond mere memorization. Students not only learn what something is, but also why and how it works. With a solid conceptual understanding, knowledge becomes more durable and transferable across different context. Moreover, it improves students' problem-solving skills, as they are able to apply concept flexibly rather than relying solely on rote memory.

According to the Ministry of National Education (in Putri et al., 2024), indicators of conceptual understanding include the ability to identify concepts, explain them in one's own words, apply them in various contexts, relate them to other areas of knowledge, analyze and solve problems based on those concepts, and address misconceptions. These six indicators provide a comprehensive framework for evaluating and fostering conceptual understanding within the learning process.

Conceptual understanding is the minimum competency that students must master in a given subject. Therefore, several strategies can be implemented by teachers to foster conceptual understanding in the classroom, namely: (1) the constructivist approach, which emphasizes that students build their own knowledge through experience and interaction with the environment; (2) the use of real-world contexts, where teaching concepts by relating them to everyday situations helps students grasp their relevance and practical applications; (3) discussion and question-and-answer methods, which engage students in open dialogue, allowing them to express their understanding while identifying and addressing misconceptions; (4) collaborative learning, where students exchange ideas and perspectives, thereby deepening their comprehension of the material; and (5) the use of technology and simulations, which can help students visualize how a concept works in real-life settings or in experiments that may not be feasible in the classroom (Wibowo, 2023).

1.2 Problem-Solving Skills

Problem-solving skills have attracted the attention of experts across various fields, including psychology, education, and cognitive science. Each discipline offers different definitions and perspectives on problem-solving. For instance, Robert Sternberg (as cited in Rowe, 2024) describes problem-solving as a cognitive process that involves identifying and understanding problems, developing strategies to address them, and evaluating the outcomes. Sternberg views problem-solving as a critical thinking skill that can be cultivated through experience and practice. Similarly, Herbert A. Simon (1996) defines problem-solving as a decision-making process within complex contexts. He characterizes it as a heuristic process, wherein individuals apply specific strategies to reduce the complexity of a given problem. Based on these perspectives, problem-solving can be understood as a crucial skill encompassing various cognitive components such as critical thinking, creativity, and logical reasoning. Mastery of these skills enables students to become more independent learners and equips them to face real-world challenges effectively.

Problem-solving indicators, as described by Polya (1945), outline a structured and systematic approach to learning. The problem-solving process involves four key stages: (1) Understanding the Problem, where students or individuals must grasp the nature of the problem, including the given conditions, desired outcomes, and existing constraints; (2) Devising a Plan, which entails formulating a strategy to solve the problem using relevant concepts, specific techniques, or algorithms; (3) Carrying out the Plan, the implementation phase where the chosen strategy is executed; and (4) Looking Back, which involves reviewing and evaluating the solution to ensure its correctness and effectiveness.

Problem-solving skills are essential in the learning process, as they support the development of higher-order cognitive abilities, character formation, and preparedness for real-world challenges. Engaging in problem-solving activities encourages students to think critically, creatively, and independently, while also fostering social competencies such as collaboration and self-reflection. This approach contributes to more relevant, meaningful, and applicable learning experiences in everyday life. The significance of problem-solving skills is further emphasized by the 21st-century skills framework, which identifies problem-solving as a core competency that must be cultivated in education. One effective strategy to enhance students' problem-solving abilities is the integration of technology in the learning process. Through appropriate technological support, students can improve their capacity to identify, analyze, and solve problems in more efficient and innovative ways.

1.3 The Role of Digital Technology in Understanding Concepts

Digital technology plays a significant role in improving students' conceptual understanding. Based on the reviewed articles, various digital tools have been utilized to support the development of mathematical concept comprehension. These tools include Kahoot, Microsoft Teams, Microsoft Forms, Nearpod, Construct 2, Geoshape, Miro, Teams Room, Google Docs, Quizizz, Wordwall, and FlipPDF.

Kahoot is a web-based digital educational platform that is freely accessible and widely used for various forms of assessment, including online quizzes, surveys, and discussions (Purwadi, 2022). In a study conducted by Purwadi (2022), Kahoot was utilized as a digital support tool for the Realistic Mathematics Education (RME) approach. The findings indicated that the integration of the RME approach with Kahoot was effective in improving students' understanding of mathematical concepts. Moreover, the use of Kahoot significantly increased students' motivation to engage in the learning process. Similarly,

research by Khasanah et al. (2024) found that Kahoot could serve as an interactive game-based medium that teachers can effectively implement in classroom settings.

Microsoft Teams and Microsoft Forms are widely used as platforms for student interaction (Bruce et al., 2020). While these tools are user-friendly for students, they do not inherently support mathematics learning. Therefore, their effectiveness in math education can be enhanced when integrated with other tools specifically designed to support mathematical learning. In a study by Bruce et al. (2020), a combination of Microsoft Teams and Microsoft Forms was used alongside Nearpod. The Nearpod tool is more interactive and offers enhanced opportunities for student collaboration, making it a valuable complement to the former tools in mathematics instruction.

Construct2 is an application that can be utilized to create Android-based digital literacy media. In a study conducted by Nurmala and Maulina (2023), Construct2 was employed to develop an Android-based digital media called "Lotika", which stands for Mathematical Logic. The "Lotika" media includes material descriptions, sample questions, and practice exercises. The results of the study indicated a significant improvement in students' conceptual understanding after using the "Lotika" Android-based digital literacy media.

Geoshape is a mathematics (geometry) learning tool that presents engaging and interactive two-dimensional images. As an interactive computer application, Geoshape includes exercises, quizzes, and questions that can be directly engaged with by students. In a study by Hariyono and Widhi (2021), it was found that Geoshape significantly aids students in understanding geometric concepts.

The next set of tools includes a combination of Miro, Teams Room, and Google Docs, as discussed in the study by Albino et al. (2024), which utilizes internet-based technology. Miro is a digital whiteboard that offers several functionalities. According to Albino et al. (2024), Miro allows students to engage in various activities. First, it provides a space and tools for interaction in the form of writing and note-taking. Second, it offers the opportunity to use diverse semiotic systems, such as images, text, tables, and more. Third, it encourages students to think critically and communicate with each other. Teams Room is a virtual meeting space, and, as explained by Albino et al. (2024), this tool enables students to add another layer of interaction through voice communication, which is familiar to them. Google Docs serves as an online platform for note-taking, allowing both personal and shared documents for collaborative writing.

In addition to the tools mentioned above, digital technology that contributes to students' understanding of mathematical concepts can also take the form of digital products, such as pre-made slides, instructional videos, digital worksheets (LKPD), and others. Based on the analysis of the articles we conducted, several digital products were identified, including Patt_Art, Digital LKPD, Digital Games-Based Learning (DGBL), and Internet Technology-based learning materials.

Patt_Art is a type of digital visual media, derived from the combination of the words "pattern" and "art." In his research, Rohmah (2019) explained that Patt_Art media integrates elements of pattern recognition and art through interactive play activities. According to their findings, Patt_Art media is more effective than conventional media in improving learning outcomes.

Digital LKPD refers to a digital version of the traditional worksheet, which can be accessed using digital technology, in contrast to the conventional paper-based worksheets. Boru (2024) explained that with digital LKPD, students can receive stimuli from various media, such as images, readings, and videos. He further emphasized that digital LKPD has the potential to make the learning process more effective, as it can be accessed anytime and integrated with instructional videos. In his study, Boru et al. (2024) suggested that research be conducted using the RME Approach based on Digital LKPD to enhance students' ability to understand mathematical concepts.

Digital Games Based Learning (DGBL) refers to learning through digital games. Shi (2022) suggested that each game provides students with progressively challenging levels. As students complete each level, they advance to more difficult stages, such as answering additional questions or dealing with larger numbers. Consequently, through repeated practice, students can develop a basic understanding of mathematical concepts while being motivated to improve their average scores in order to reach the next level and gain an advantage in the game. Similarly, Orhani (2023) noted that Digital Games can be highly effective in improving student learning and satisfaction in mathematics, provided that students actively engage with and critically evaluate the mathematical concepts presented within the game.

The final digital product related to students' understanding of mathematical concepts is Internet Technology-based learning materials. Rahma et al. (2022) in their research found that improving students' analytical skills and understanding of mathematical concepts through project-based blended learning, supported by Internet

Technology-based teaching materials, was more effective than traditional learning models typically implemented by teachers in schools. Furthermore, the study explained that the project-based method applied in online learning, with the assistance of internet-prepared teaching materials, significantly enhanced students' understanding of concepts, even without face-to-face instruction in the classroom.

1.4 The Role of Digital Technology in Solving Mathematical Problems

In addition to its role in improving students' understanding of mathematical concepts, digital technology also plays a significant role in improving students' mathematical problem-solving skills. Based on the analysis of the collected articles, several technological tools have been identified as beneficial for solving students' mathematics problems, including Liveworksheet, GeoGebra, Spreadsheets, Schoology, Edmodo, Cloud Technology (Google Docs, Google Slides, Google Drive, Google Meet, Google Classroom, and SlideShare), Desmos, and Padlet.

Liveworksheet is an example of a digital-based mathematics teaching material that enables both teachers and students to access, interact with, and practice mathematical concepts in a dynamic and interactive manner (Qudwatullathifah et al., 2023). In their research, Qudwatullathifah et al. (2023) utilized the LiveWorksheet platform as a teaching tool by providing learning materials and problem-solving exercises. The results indicated that the use of this digital platform significantly enhanced students' problem-solving skills in mathematics education.

GeoGebra is a widely recognized tool used to learn various mathematical concepts, including geometry, algebra, and calculus. In a study by Jacinto (2023), which observed learning clubs in the Tecn@Mat Club, it was explained that GeoGebra is employed to create features such as drawing and construction, as well as for calculating areas and creating spreadsheets.

GeoGebra is a widely recognized tool used as a learning medium. It is a software designed to teach various mathematical concepts, including geometry, algebra, and calculus. In a study by Jacinto (2023) on the observation of Tecn@Mat Club learning activities, it was explained that GeoGebra is used for tasks such as drawing and calculating the area of geometric shapes. Jacinto (2023) also noted the use of spreadsheets in the software, which are employed for writing, formatting cells (adjusting the display of tables), auto-completing cells (a feature that automatically fills or suggests data entries), and determining numerical and algebraic relationships, particularly in the context of perfect squares. Schoology, a

Learning Management System (LMS) resembling a social network, offers free learning environments similar to traditional classrooms. Darma (2023) highlighted that Schoology has unique features not found in other LMS platforms, such as facilities for writing mathematical symbols and equations. In his research, Darma (2023) concluded that digital mathematics textbooks, combined with Schoology, have a significant positive impact on improving mathematics problem-solving skills in a blended learning environment. This finding aligns with the research conducted by Dewi et al. (2023), which also found that the use of Schoology technology has a notable effect on problem-solving abilities.

Edmodo is a valuable learning support tool. Wardono et al. (in Misa & Mariani, 2021) explained that Edmodo offers a variety of features, including providing a secure platform for students to communicate, collaborate, share content, engage in virtual class discussions, conduct online exams, and receive grades, among other functionalities.

Cloud technology, in the form of Google Docs, Google Slides, Google Drive, Google Meet, Google Classroom, and SlideShare, is widely utilized in education. Chimmalee & Anupan (2022) explained that Google Docs allows students to read or listen to given problems, articulate their ideas, and discuss their daily lives and experiences. Google Drive is used by students to evaluate the accuracy of their solutions. Additionally, a combination of Google Docs, Google Slides, and Google Meet can facilitate problem-solving using mathematical modeling. Google Classroom and Google Drive enable students to discuss the relevance and applicability of mathematical models, as well as assess whether solutions are applicable to similar situations. Furthermore, the combination of SlideShare and Google Meet allows students to present and explain their ideas and problem-solving strategies.

Desmos is a prominent web-based graphing calculator platform used by both teachers and students. The Desmos workspace serves as an excellent starting point for engaging students in exploring and testing mathematical problem-solving ideas, as well as fostering collaboration and sharing (Rajkumar et al., 2019).

Padlet is a cloud-based software that enables users to collaborate by uploading, organizing, and sharing content through virtual boards (Cavalletti et al., 2024). The use of Padlet transforms the dynamics of math discussions in the classroom during problem-solving activities. Discussions are driven by various levels of interrelated interactions, and posts on Padlet are utilized by teachers to promote engagement among students (Cavalletti et al., 2024). In their research, Cavalletti et al. (2024) concluded that Padlet is an effective tool,

even for younger students, to support mathematical discussions and encourage the comparison of different problem-solving strategies, thus fostering participation among students with diverse needs.

In addition to tools, digital products also play a significant role in solving mathematical problems. These products include digital book media, digital LKPD, and digital games. Digital book media refers to digital books that replace traditional paper-based books. According to Buchori et al. (2021), using digital books as a medium for learning mathematics can stimulate students' motivation and interest in the subject. Their research concluded that digital book media, when combined with the Contextual Teaching and Learning (CTL) approach, is proven to be practical, valid, and effective in improving students' problem-solving skills in mathematical economics. Similarly, Bakoban et al. (2022) found that students' problem-solving abilities improved when using interactive digital books developed based on the Realistic Mathematics Learning approach, specifically in topics like squares and rectangles, as shown by the increased scores from trial I to trial II.

In addition to digital book media, digital LKPD is also utilized to enhance students' problem-solving skills. Electronic LKPD is a type of teaching material that can be accessed through a computer or mobile device, such as a smartphone, and may include videos and other animated content, making it more engaging and relatable for students (Hendriani & Gusteti, 2021). Research by Ningrum et al. (2022) shows that the quality of interactive digital LKPD developed with a Realistic Mathematics Education (RME) approach to improve problem-solving skills in social arithmetic materials meets the criteria of validity, practicality, and effectiveness. This study found that students' learning outcomes, as reflected in their mathematical problem-solving skills, showed significant improvement from the pretest to the posttest after using the developed products.

Digital games, in addition to their role in improving students' understanding of mathematical concepts, also contribute significantly to improving their problem-solving skills. According to research by Muslikasari & Rusnilawati (2023), students' attitudes and problem-solving abilities in mathematics improved more effectively after using the role-playing learning model with digital games, compared to the cooperative learning model that utilized fractional board media.

Conclusion and Suggestion

Digital technology plays a significant role in improving students' conceptual understanding and their ability to solve mathematical problems. The role is evident through the various digital tools and products utilized in the learning process. In relation to improving students' understanding of mathematical concepts, the tools and digital products include Microsoft Teams, Microsoft Form, Nearpod, Kahoot, Construct 2, Geoshape, Miro, Teams Room, Google Docs, Quizizz, Wordwall, FlipPDF, Patt_Art, digital LKPD (Learning Activity Sheets), Digital Games Based Learning (DGBL), and learning materials based on Internet Technology.

In relation to the role of digital technology in improving mathematical problem-solving skills, the digital tools and products used include Liveworksheet, GeoGebra, Spreadsheet, Schoology, Edmodo, Cloud Technology (Google Docs, Google Slide, Google Drive, Google Meet, Google Classroom, and SlideShare), Desmos, Padlet, digital book media, digital LKPD, and digital games.

From these tools, Google Docs, digital LKPD, and digital games/Digital Games Based Learning are identified as versatile, supporting both conceptual understanding and problem-solving skills. On the other hand, tools such as Microsoft Teams, Microsoft Form, Nearpod, Kahoot, Construct 2, Geoshape, Miro, Teams Room, Quizizz, Wordwall, FlipPDF, Patt_Art, and learning materials based on Internet Technology are predominantly utilized for conceptual understanding. Conversely, Liveworksheet, GeoGebra, Spreadsheet, Schoology, Edmodo, Cloud Technology components (Google Slide, Google Drive, Google Meet, Google Classroom, and SlideShare), Desmos, Padlet, and digital book media are primarily associated with enhancing mathematical problem-solving skills.

Future research could explore more effective teaching strategies in utilizing digital technology, ensuring that it not only enhances conceptual understanding and problem-solving skills but also fosters students' independent learning.

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