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Digital learning using ChatGPT in elementary school mathematics learning: a systematic literature review

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ABSTRACT

Digital learning with ChatGPT in elementary school mathematics learning is urgently implemented. Several studies have explored digital learning with ChatGPT in elementary school mathematics learning, but studies using SLR are minimal. This article presents the 2022-2024 SLR study on digital learning with ChatGPT in elementary school mathematics learning. This SLR and PRISMA method is supported by Publish or Perish 8, VOSviewer version 1.6.20, Mendeley version 1.19.8, and ATLAS.ti version 7.5.16. The search results obtained 1,259 Scopus articles, which were filtered to 40 and analyzed using ATLAS.ti, then the results were described according to the research question. Digital learning with ChatGPT is a learning approach using the synchronous-asynchronous mode, virtual classrooms, distance, use of interactive digital tools, digital methods and media, innovation, digital modeling, use of robotics and AI ChatGPT for children with the principle of collaboration digital, and problem-solving with the support of digital resources. ChatGPT features multilingual, natural language, advanced AI, 24/7 availability, answering math questions, recurring training, and helping students with various math tasks. Implementation of digital learning with ChatGPT in elementary school mathematics learning for problem-solving, geometry, function limits in algebra, the material on flat shapes, geometric shapes, integrated PjBL, online, mixed and flipped classes.

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1. INTRODUCTION

In various countries, research on digital learning with digital technology, applications, games, ChatGPT, and elementary school mathematics learning in the last year. These researches include team project-based digital learning [1], digital learning with Maktabah Syumilah NU 1.0 in Islamic boarding schools [2], mathematical problem solving with ChatGPT [3], reverse learning in mathematics education with Chatbots [4], android media in elementary school mathematics learning [5], solving mathematics problems via ChatGPT [6], ChatGPT and mathematics skills [7], and using ChatGPT in elementary school for solving mathematics problems as a substitute for a calculator [8]. From these research studies, no research has been found on digital learning with ChatGPT in elementary school mathematics learning with a systematic literature review (SLR). Research on digital learning using ChatGPT and elementary school

mathematics learning for 2023-2024 was found with a SLR and minimal review literature. These researches are SLR about digital learning management with ChatGPT [9], SLR about students' mathematics learning difficulties [10], SLR about the limitations and concerns of using ChatGPT in education [11], SLR about methods, uses, and challenges of AI chatbot in education [12], SLR and ChatGPT taxonomy in health care [13], and a literature review on mathematical literacy and elementary school curricula [14]. Based on these facts, the literature confirms that research on digital learning with ChatGPT in elementary school mathematics learning with systematic literature reviews still needs to be improved and urgently carried out.

Digital learning with ChatGPT in elementary school mathematics learning has empirically become a promising innovation [15]. The reason is that ChatGPT, developed by OpenAI, allows interaction between users and the system in natural language, similar to communicating with students in answering elementary school mathematics problems [16]. E-learning in this context also influences the academic achievement of elementary school students [17]. Apart from that, teacher motivation, efficacy, and digital learning make it easier for them to teach mathematics, with evidence that elementary school students have academic enthusiasm for learning mathematics [18]-[20]. Digital learning in elementary school mathematics learning is an innovation that many teachers have implemented because mathematics learning is often faced with challenges in maintaining student interest and involvement [21], [22]. Therefore, studying digital learning with ChatGPT in elementary schools in mathematics is intriguing. Conventional learning without tools, applications, and digital technology is considered less attractive for students and causes low success and a lack of self-confidence in mathematical abilities [23], [24]. However, with technological advances, especially the intelligence of ChatGPT, educators can change the conventional elementary school mathematics learning approach to digital. The use of ChatGPT in mathematics learning promises a more interactive, effective, and responsive approach [25]. With its ability to understand and process natural human language, ChatGPT provides individualized explanations, exercises, and guidance to each student. This allows learning to be tailored to each student's needs and level of understanding and increases the overall effectiveness of learning [26]. However, using ChatGPT in mathematics learning faces several challenges and ethical considerations: data security, technology sustainability, and potential dependence on technology [27]. It is also essential to ensure that the use of ChatGPT does not replace the role of the teacher but becomes a tool that supports and strengthens the student learning experience [28].

Digital learning with ChatGPT in this research is a learning approach using digital technology in the learning process to increase the effectiveness and efficiency of learning using the AI ChatGPT platform combined with technological pedagogical content knowledge (TPACK) by elementary school teachers [29], [30]. The concept of digital learning broadly involves the use of various hardware and software such as computers, tablets, smartphones, learning software (applications, e-learning platforms), games, esports games [31], digital video learning resources, interactive simulations, and multimedia content [32]. In this research, digital learning is limited to using ChatGPT artificial intelligence, which is integrated with other tools currently trending in the latest literature [33]. ChatGPT has advantages and disadvantages. However, digital learning with ChatGPT in elementary school mathematics learning provides interaction and responsiveness, is conversation-based, problem-based, provides feedback, and provides multimodal media such as graphics, images, videos, and websites, which make students learn mathematics more comprehensively [34], [35].

Studying digital learning with ChatGPT is essential because it will explore further how the concepts, features, and implementation of digital learning with ChatGPT in elementary school mathematics learning can positively contribute to improving the quality of learning and student engagement. By considering the benefits, challenges, and ethical implications, we can understand the potential role of this technology in shaping the future of more inclusive and effective mathematics learning [36], [37]. Based on the background, research on digital learning with ChatGPT in elementary school mathematics learning is urgently carried out. To answer this, the researchers asked three research questions: i) What is the concept of digital learning with ChatGPT in elementary school mathematics learning? ii) How is the ChatGPT feature in elementary school mathematics learning? Moreover, iii) How is digital learning with ChatGPT implemented in elementary school mathematics learning?

2. METHOD

2.1. Research design

This research applies the SLR method by identifying articles published in 2022-2024 compatible with digital learning with ChatGPT in elementary school mathematics learning regarding concepts, features, and implementation in the Scopus database. This research aims to present findings and analysis about digital learning with ChatGPT in elementary school mathematics learning with a systematic literature review. The SLR design in this research uses the preferred reporting items for systematic reviews and meta-analyses (PRISMA) technique with the steps of identification, screening, testing feasibility, data inclusion, analysis, and presenting findings in the form of descriptions according to research questions [38], [39].

2.2. Inclusion and exclusion criteria for selection of publications

At this stage, eight criteria were determined for the literature to be searched, namely i) English language articles; ii) articles indexed by the Scopus database; iii) peer-reviewed scientific articles are used, literature such as papers, conference proceedings, research reports, policy briefs, book chapters, books, theses, and dissertations are not used; iv) the literature searched is by the topic of digital literacy using ChatGPT in elementary school mathematics learning; v) articles published in 2022-2024; vi) the selected articles are full PDFs; vii) literature published with open access status from a Scopus indexed journal and close access is not used; and viii) Publish or Perish 8 is used as an article search application, not from other applications.

2.3. Screening and eligibility assessment for data analysis

Screening of articles from Scopus via Publish or Perish 8 was carried out on February 28, 2024. Filtering on tit-abs-key aspects precisely according to the theme of digital learning with ChatGPT in elementary school mathematics learning. These findings are the basis for determining the article inclusion and exclusion process. The search results obtained 1,259 articles from Scopus, with details in Table 1.

Table 1. Article findings for 2022-2024 via Publish or Perish 8

Numb.	Keyword	Quantity
1	Digital learning	200 articles
2	Digital learning in mathematics	200 articles
3	Digital learning in elementary school mathematics	53 articles
4	Digital learning using ChatGPT	182 articles
5	ChatGPT	200 articles
6	Using ChatGPT in Digital Learning	175 articles
7	Using ChatGPT in Elementary Math Learning	2 articles
8	ChatGPT Learning in Elementary School	8 articles
9	ChatGPT in Elementary School	8 articles
10	Learning Mathematics with ChatGPT	31 articles
11	Learning elementary school mathematics	200 articles
	Quantity	1,259 articles

Of the 1,259 articles obtained, the same articles were discarded, and 40 remained. To search for initial network mapping, the researchers entered the 40 selected articles into the Mendeley Desktop version 1.19.8 application, which was saved in RIS format to be entered the VOSviewer version 1.6.20 application. The topic of digital learning with ChatGPT in elementary school mathematics learning refers to the results of the initial analysis of thematic associations depicting very complex association patterns in Figure 1 and the visualization of the distribution of articles based on keywords in VOSviewer in Figure 2.

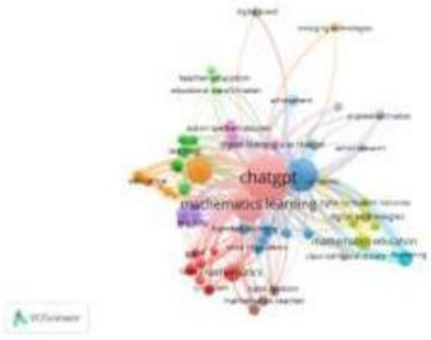
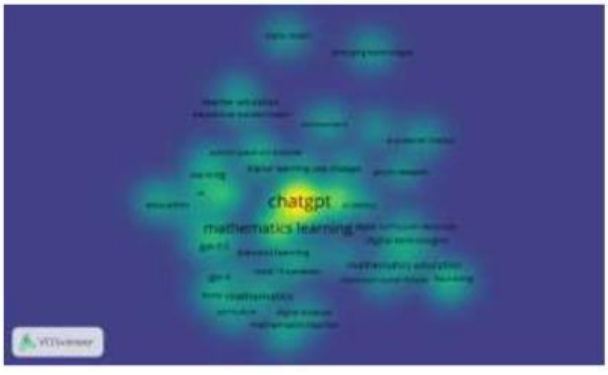


Figure 1. Initial network visualization in VOSviewer



Figures 2. Visualization of article distribution based on keywords

Figures 1 and 2 show that studies related to digital learning with ChatGPT in elementary school mathematics learning are very close to several other study themes such as mathematics learning, blended learning, mathematics, artificial intelligence, GPT-3.5, learning, teaching, digital curriculum resources, digital technologies, mathematics education, distance learning, robotics, AI literacy, action research, AI-

powered chatbots, artificial intelligence education, digital learning management, chatbots, and language models. Some keywords far from the central study theme are digital textbook, mathematics teacher, Colby Tofel-Grehl, digital board, and emerging technologies.

2.4. PRISMA flow diagram

The PRISMA technique is applied in searching articles through four stages, namely identification, screening, eligibility, and inclusion. Each stage determines the results of quality articles with the help of the application chosen by the researcher. Each stage was carried out using the Publish or Perish 8 application, VOSviewer version 1.6.20, and Mendeley Desktop version 1.19.8. The search stages using the PRISMA flow diagram are explained in Figure 3.

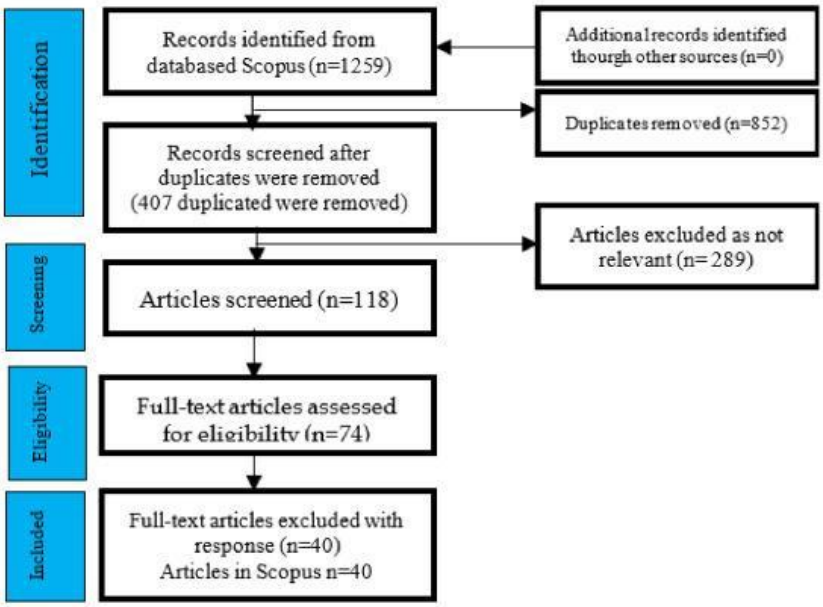


Figure 3. PRISMA flow diagram for systematic review [31]

At the identification stage, 1,259 articles were indexed by Scopus using the Publish or Perish 8 application (see Table 1). At the screening stage, there were 852 similar articles referring to keywords, and 407 remained. At the screening stage, determining similarities did not refer to a database because the SLR method only uses Scopus, so determining similarities was based on the specified keywords. From the screening stage, 118 articles were selected, and 289 pieces of irrelevant literature were discarded. At the eligibility stage, 74 full-text articles were selected to be read and analyzed, while 34 articles were not used. Included were 40 selected articles referring to research questions in terms of tit-abs-key and the substance of the literature. The next stage is that 40 full PDF articles are entered the ATLAS.ti version 7.5.16 application to be analyzed, mapped and presented the results referring to three research questions. The use of ATLAS.ti was chosen because it produces findings and categorizations that have more context in digital learning using ChatGPT.

3. RESULTS AND DISCUSSION

Before presenting the results of the analysis according to the three research questions, 40 articles were first presented. Table 2, 40 articles are presented with journal criteria (journal name, volume, edition, and year of publication), country of research, methodology, and research question (RQ), namely RQ 3.1. The concept of digital learning with ChatGPT in elementary school mathematics learning; 3.2. ChatGPT feature in elementary mathematics learning; 3.3. Implementation of digital learning with ChatGPT in elementary school mathematics learning in Table 2.

Table 2. Finding 40 articles from the Scopus database

No	Journals	Countries	Method	RQ
1	Computers and Education: Artificial Intelligence 2 2022 [40]	China	Exploratory Study	3.1
2	Journal of Computers in Education 9 (1) 2022 [41]	China	Sequential mixed-method	3.1
3	Computers in Human Behavior 132 2022 [42]	Swiss	Online survey	3.3
4	Education Sciences 12 (459) 2022 [43]	Greece	Investigative research	3.3
5	EURASIA Journal of Mathematics, Science and Technology Education 18 (2) 2022 [44]	Russia and Uzbekistan	Quantitative	3.1
6	E-Learning and Digital Media 2022 [45]	India	Design-Based Research (DBR)	3.3
7	Mathematics 10 (1808) 2022 [46]	Indonesia	Quantitative	3.3
8	Scientometrics (127) 2022 [47]	Several countries	Bibliometric analysis	3.3
9	Journal of Internet Technology Vol. 23 No. 6 2022 [48]	Taiwan	Quasi-experiment	3.2
10	Frontiers in Virtual Reality Vol. 3 2022 [49]	United States	Exploratory Study	3.1
11	International Journal of Science and Mathematics Education (20) 2022 [50]	Germany	Grounded research	3.3
12	Frontiers in Psychology (12) 2022 [51]	China	Experimental research	3.3
13	Acta Scientiae 24 (5) 2022 [52]	Brazil	Content analysis	3.1
14	International Journal of Education in Mathematics, Science, and Technology, 10 (3) 2022 [53]	Russia	Survey research	3.1
15	Education Sciences, 13 (410) 2023 [54]	Several countries	Systematic Reviews & Meta-Analysis	3.2
16	Frontiers Education 11 2023 [55]	Several countries	Descriptive SLR	3.1
17	International Journal of Learning, Teaching and Educational Research 22 (7) 2023 [56]	Several countries	SLR	3.2
18	Internet of Things and Cyber-Physical Systems 3 2023 [57]	Several countries	Review papers	3.2
19	EURASIA Journal of Mathematics, Science and Technology Education, 19 (7) 2023 [58]	Saudi Arabia	Qualitative case study	3.3
20	Acta Scientiae, 25 (6) 2023 [59]	Brazil	Action-research	3.3
21	Applied science, 13, 6039, 2023 [60]	Spain	Case Study	3.3
22	Journal of Advanced Research in Applied Sciences and Engineering Technology 32, 2 2023 [61]	Indonesia	DGBL-ID Method	3.3
23	Cogent Education (10) 2, 2023 [62]	Several countries	Literature review & bibliometric analysis	3.2
24	Learning Environments Research 26 (2) 2023 [63]	Germany	Cross-sectional explorative	3.3
25	SSRN Electronic Journal 2023 [64]	India	Explorative research	3.2
26	Journal of Applied Learning and Teaching, 6, 2 2023 [65]	United Arab Emirates	Comparative analysis	3.2
27	Smart Learning Environments 10, 52, 2023 [66]	China	Exploratory Research	3.2
28	The International Journal of Management Education 21 (100857) 2023 [67]	Australia	Academic research	3.2
29	Computers, 12, 153, 2023 [68]	Several countries	Systematic Review	3.2
30	International Journal of STEM Education 10, 8, 2023 [69]	Singapore	Case study	3.1
31	Mathematics Education Research Journal, 35 (Suppl 1) 2023 [70]	Aotearoa New Zealand	Survey	3.1
32	Pythagoras, 44 (1) 2023 [71]	Cape Town, South Africa	Transformation Research	3.2
33	Journal of Education and e-Learning Research, 10, 4 2023 [72]	Indonesia	Experimental design	3.1
34	Iraqi Journal for Computer Science and Mathematics 5 (1) 2024 [73]	Emirate of Abu Dhabi	Descriptive analytical approach	3.1
35	Environment and Social Psychology 9 (1) 2024 [74]	Philippines	Preliminary study	3.3
36	Frontiers in Education 2024 [75]	Indonesia	Case study	3.3
37	EURASIA Journal of Mathematics, Science and Technology Education, 20 (1) 2024 [76]	Thailand	Study investigates	3.3
38	Cogent Education 11, 1, 2024 [77]	Canada	Mixed methods	3.1
39	Heliyon 10 (2) 2024 [78]	China	Exploratory Research	3.2
40	International Journal of Information and Education Technology, 14 (2) 2024 [79]	United Arab Emirates	Case study	3.1

3.1. The concept of digital learning with ChatGPT in elementary school mathematics learning

Digital learning is an approach to learning in elementary schools using synchronous-asynchronous mode, in virtual/online classrooms, long distance, using digital technology [41], interactive digital tools for children [44], digital methods, digital media, digital boards [52], innovation, digital modeling [55], use of

robotics [49], and AI ChatGPT for children with the concept of "AI for Kids" in learning mathematics, Science, Technology, Engineering, Art, and Math (STEM) [40]-[69], with principles of digital collaboration, and problem-solving [77]. Digital learning with ChatGPT is collaborated by teachers in teaching mathematics learning with the help of other forms of artificial intelligence, tablets, e-readers, gadgets, digital music, smartphones, laptops, mobile devices [55], metaverse technology, and meta-STEM [72]. Digital learning with AI ChatGPT is an educational-learning approach with artificial intelligence in education (AIED) concept with interactive, practical, and multimodal computer-human learning [73]. Digital learning in elementary school mathematics teaching is an online-based learning paradigm and approach that utilizes ChatGPT with the support of digital resources, digital curriculum, digital tools, videos, digital images [70], syllabus, learning planning, materials, class rules, classrooms, discussion instructions, presentation scripts, and good digital-based classroom management [79].

3.2. ChatGPT feature in elementary school mathematics learning

As a computer program, ChatGPT is a new-generation AI tool that has multilingual features, natural language, advanced AI, and 24/7 availability that can be accessed worldwide and used in learning, including elementary school mathematics [67], [68]. The ChatGPT feature can answer math questions, provide iterative training, and help students with various math tasks [71]. ChatGPT is an artificial intelligence-based chatbot released in November 2022. It is a digital learning medium for learning mathematics, virtual tutoring, programming [54], writing text, editing, paraphrasing, and giving academic assignments to students [56]. ChatGPT is an AI product developed by OpenAI with various versions and users, namely GPT-1 (general), GPT-2 (general), GPT-3 (general), InstructGPT (conservation), ProGPT2 (protein sequences), BioGPT (biomedical content), ChatGPT (dialogue), and the latest in 2023 is GPT-4 (general) [57]. Meanwhile, the chatbot versions ChatGPT, GPT-4, Bard, and LLaMA are used for learning calculus and statistics [65], ChatGPT and LLMs for digital learning of arithmetic material, mathematical problem solving, and symbolic reasoning [66]. The ChatGPT feature, as an advanced AI tool, revolutionizes education and learning and is used to help with academic tasks, counseling, creative intelligence, and mathematical problem-solving [62]. The intelligent features of ChatGPT in elementary school mathematics learning are suitable in interactive games on fractions, measurements, adding units, and comparing simple fractions [48]. Digital learning with ChatGPT in mathematics learning offers assistance in problem-solving, conceptual clarity, adaptive techniques, integration of mathematical fields, increased accessibility, encouragement of critical thinking, creativity, language translation, and interactive learning [64]. ChatGPT, as a digital learning tool, has shortcomings, namely the accuracy of question answers, risk of knowledge plagiarism, data contamination problems, and ethical and security issues [78].

3.3. Implementation of digital learning with ChatGPT in elementary school mathematics learning

The implementation of digital learning with ChatGPT in elementary school mathematics learning is very much determined by teachers who must have digital competence [42]. In mathematics learning in elementary school, ChatGPT develops from generative artificial intelligence (GAI), generative adversarial network (GAN), and generative pre-trained transformer (GPT) for learning mathematical problem solving, geometry, function limits in algebra such as mapping output f(x) for each input x, namely the limit L at the input point p if f(x) is close to L when x is close to p [58], and the development of interactive mathematics educational games for plane and spatial shapes [61]. Digital learning is practiced with ChatGPT integrated Project-Based Learning in elementary school mathematics learning [59], online models [47], mixed, flipped classes in elementary school mathematics learning [45], digital mathematics textbooks [46], digital classrooms in number material, operations, geometry, measurement, data analysis, algebra, probability [43], learning to read comprehension of elementary mathematics texts [50], learning geometry [51], and drawing elementary mathematics problems [63]. ChatGPT also collaborates with Google Colab with preparation, practice procedures (task analysis, prompt crafting, prompt operation, code execution, result verification, and summarization), and exploration [76]. After the pandemic, digital learning was practiced with blended learning in elementary school mathematics learning on material on mathematical problem solving, working on questions in groups, critical thinking, calculations [60], use of mathematical symbols and language, derivatives, limits, integration, fractions, intervals, exponentials [74], and tetrahedron learning [75].

4. CONCLUSION

Digital learning with ChatGPT in elementary school mathematics learning is a learning approach in elementary schools using the synchronous-asynchronous mode, virtual/online classrooms, distance, digital technology, interactive digital tools for children, digital methods, digital media, digital boards, innovation, digital modeling, use of robotics, and AI ChatGPT for children with the concept of "AI for Kids" in learning

mathematics, STEM, with the principles of digital collaboration, and problem-solving with the support of digital resources. ChatGPT features in elementary school mathematics learning include multilingualism, natural language, advanced AI, 24/7 availability that can be accessed worldwide, answering math questions, repeated training, helping students with various math tasks with the GPT-1 (general) version, GPT-2 (general), GPT-3 (general), InstructGPT (conservation), ProGPT2 (protein sequences), BioGPT (biomedical content), ChatGPT (dialogue), GPT-4 (general), Bard, LLaMA, and LLMs. Implementation of digital learning with ChatGPT in elementary school mathematics learning in learning mathematical problem solving, geometry, function limits in algebra such as mapping the output f(x) for each input online, mixed, flipped classes in numbers, operations, geometry, measurement, data analysis, algebra, probability, mathematics texts, drawing math problems, derivatives, limits, integration, fractions, intervals, exponentials, and tetrahedron learning that can be collaborated with Google Colab. This research is limited to only reviewing articles from 2022-2024, not field research. Further research is needed on digital learning with ChatGPT in elementary school mathematics learning that examines it in depth.

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