International Journal of Learning, Teaching and Educational Research
Vol. 23, No. 12, pp. 96-112, December 2024
https://doi.org/10.26803/ijlter.23.12.6
Received Oct 9, 2024; Revised Dec 15, 2024; Accepted Dec 18, 2024

Digital Literacy in Elementary Schools Post COVID-19: A Systematic Literature Review

Ari Wijayanti, Siti Irene Astuti Dwiningrum and Bambang Saptono
Faculty of Education and Psychology
Yogyakarta State University
Yogyakarta, Indonesia

Abstract. This research aims to analyze digital literacy in primary schools after the pandemic. Studies from Scopus, ScienceDirect, and Eric were systematically reviewed. Findings revealed five main topics based on dominant keywords: (i) education; (ii) school, learning; (iii) primary, digital, online; (iv) literacy; and (v) evaluation, intelligence, teacher, and analysis. The dominant methodologies in digital literacy research in post-pandemic were quantitative (65%). In implementing post-pandemic primary school digital literacy, there were four dominant strategies: the use of digital content, digital games, the use of hardware, and digital competency tests. Teachers had roles in post-pandemic primary school digital literacy, including facilitators, curriculum implementers, collaborators, and digital content creators. Implementing post-pandemic digital literacy still faces challenges from teachers and students. The obstacles regarding pupils included the need for assistance in using digital material, difficulty in evaluating the reliability of online information sources, insufficient levels of digital competence, and issues related to cyberbullying. The digital literacy challenges faced by educators included a teacher training curriculum that omits artificial intelligence (AI), insufficient information technology training, inadequate preparedness for instructing students, infrastructural obstacles, and a disparity between teacher readiness and technological advancement. The recommendations for future research are to explore the keywords "evaluation", "intelligence", "teachers", and "analysis". The research methods on digital literacy, combined with mixed methods, research and development, still need to be explored. Future research can examine digital literacy issues from the perspective of teachers and students and expand search keywords by including the keyword "post-COVID-19".

Keywords: digital literacy; elementary school; post-pandemic; learning strategies, teachers' role

1. Introduction

The COVID-19 epidemic has disrupted global life. Following its declaration as a pandemic by the World Health Organisation (WHO) on 11 March 2020, countries

adopted several measures such as lockdowns, work-from-home, school-from-home, and restrictions in various sectors of life. To control the spread of COVID-19, most countries' educational institutions closed their schools (Tarkar, 2021). Face-to-face school was not possible to prevent crowds and maintain physical distancing (Alismaiel et al., 2022). Learning that was initially carried out in schools was replaced with distance learning. Online distance learning technology was the best solution during the pandemic (Qazi et al., 2021). The online approach enables teachers and students to learn without physical meetings. Online learning became a demand/necessity? during the COVID-19 pandemic even though teachers and students were still not ready to face these changes (Ogbonnaya et al., 2020).

Online education necessitates that educators and learners adopt many digital learning systems. In addition, online learning requires systematic planning to create an effective learning ecosystem (Bordoloi et al., 2021). Digital literacy is a professional requisite for facilitating technology-integrated learning (Li & Yu, 2022). Digital literacy/It is the capacity to search, assess, organize, and execute activities using digital technologies and the Internet in educational, professional, and social contexts (Taskin & Ok, 2022). Good digital literacy can improve student achievement in online learning. Conversely, students with low levels of digital literacy and weak motivation will be less successful in online learning (Yu, 2022).

The problem that arises almost worldwide is that there is still a digital divide (Zhao & Watterston, 2021). The digital divide is characterized by unequal ability to access technology, whereas people with adequate education and financial status have good access to information technology. Meanwhile, people who do not have access to technology will develop more slowly and have a low standard of living (Sydorenko et al., 2024). This digital divide is an important reason for developing digital literacy as a solution (Nogueira et al., 2022). Schools, as agents of change, have the opportunity to play an active role and network globally even though the pandemic has passed. In the post-pandemic period, schools remain responsible for providing effective learning to improve student achievement (Nwosu et al., 2022).

Until now/Currently?, research trends on digital literacy continue to develop (Tabieh et al., 2021). Therefore, it is necessary to conduct a more focused study to obtain a complete picture related to digital literacy in elementary schools, especially after the pandemic. This study aims to analyze digital literacy in elementary schools after the pandemic. Studies were systematically reviewed to illustrate research trends, dominant methodologies, and subjects' distribution. In addition, this systematic review also aimed to analyze the strategies used in post-pandemic studies for digital literacy, the role of teachers in implementing digital literacy, and the challenges faced in implementing digital literacy in elementary schools.

The following questions were addressed in the study:

(1) What are the dominant keywords of digital literacy research in primary schools after the pandemic?
(2) What research methods have been used in digital literacy research in primary schools after the pandemic?

(3) What research subjects have been used in digital literacy research in primary schools post-pandemic?
(4) What are the digital literacy strategies for primary school students after the pandemic?
(5) What is the role of teachers in primary school digital literacy after the pandemic?
(6) What challenges have been faced in implementing digital literacy in primary schools since the pandemic?

2. Methodology

2.1 Research Design

This study used a systematic review with a qualitative approach that followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines. PRISMA outlines the scope that should be included in a systematic review and is an excellent template for formatting the report (Moher et al., 2015). In general, the image of an article using the PRISMA method presents a clear flowchart of all studies found, excluded measures, exclusions, and studies included in the systematic review (Charrois, 2015).

2.2 Search Criteria and Data Collection

The literature search was conducted using Scopus, ScienceDirect, and Eric databases. The three databases were chosen because of their wide coverage, good data quality and accuracy, ease of access, and presenting the latest research trends. The literature search aimed to download all documents focusing on primary school digital literacy in the post-pandemic period. This systematic review, according to PRISMA guidelines, delineated essential phases: (i) eligibility and exclusion criteria, (ii) identification review, (iii) screening, (iv) eligibility assessment, and (v) data abstraction and analysis (Moher et al., 2015).

Articles were collected on 20 August 2024 using four specific search criteria. First, a period restriction was made to search for articles published after the pandemic period, i.e., 2023, about the WHO's declaration of the conclusion of the COVID-19 pandemic on 5 May 2023. Second, the search used the keyword "digital literacy". Third, the search used the phrase 'primary school digital literacy.' Fourth, the search used a scope restriction with the keywords' digital literacy of primary school students OR "digital literacy of primary school teachers".' The article search in this study is depicted in Table 1:

Table 1: Search Keywords

Keywords	Database			Total
	Scopus	ScienceDirect	ERIC	
"digital literacy"	2696	8076	1007	11.779
"primary school" AND "digital literacy"	37	183	27	247
"primary school student" AND "digital literacy" OR "primary school teacher" AND "digital literacy"	5	36	2	43

The search yielded 11,779 articles. Specifically, 2 696 articles were identified from Scopus, 8 076 from ScienceDirect, and 1 007 from ERIC. Articles that fulfilled the requirements and were pertinent to the study subject were subsequently downloaded and examined. These selected articles provided insights into primary school digital literacy, particularly in the post-pandemic period. They also comprehensively understood primary school digital literacy and contributed to the science in this area.

2.3 Data Screening

Data screening followed the four steps of the PRISMA guidelines: identification, screening, eligibility, and inclusion. These four steps are visualized/depicted in the Figure 1 PRISMA flowchart:

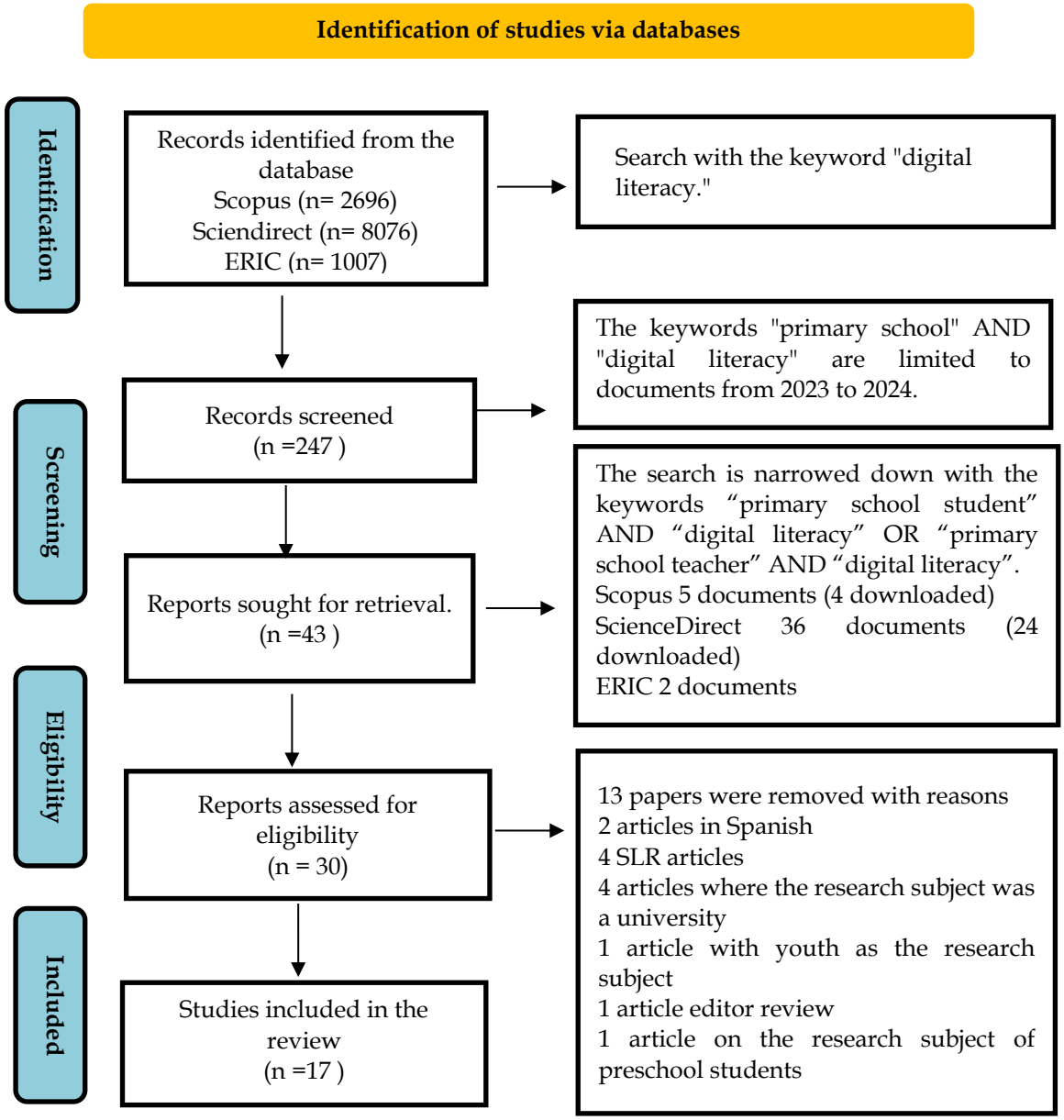

Figure 1: PRISMA flow diagram of the study

The first search using the keyword "digital literacy" resulted in 11,779 articles: 2 696 from Scopus, 8 076 from ScienceDirect, and 1 007 from ERIC. A screening process was conducted based on these identified articles. From the total number of documents obtained at the identification stage, the next step was to narrow down the search criteria with the keywords "primary school" AND "digital literacy:, limiting the search period to the range of 2023 to 2024. This search yielded 247 articles (37 Scopus, 183 ScienceDirect, and 27 ERIC). Subsequently, the search was further narrowed with the keywords "primary school student" AND "digital literacy" OR "primary school teacher" AND "digital literacy", resulting in 43 articles (5 Scopus, 36 ScienceDirect, 2 ERIC).

A total of 43 articles obtained at the screening stage were then downloaded for analysis. As many as 30 articles can be downloaded. However, not all of these articles fulfilled the requirements. As can be seen in Figure 1, 13 articles did not meet the eligibility stage while 17 articles met the criteria for review. The next step was tabulation, which presented a summary of the articles to facilitate the analysis process. An overview of the analyzed studies is provided in Table 2 below:

Table 2: Summary of the Reviewed Studies

No	Methodology	Sample	Strategies	References
1	Qualitative	15 students and 2 teachers	The use of digital content	(Jakavonytė-Staškuvienė & Ponomariovienė, 2023)
2	Qualitative (Case study)	Primary school students	The use of hardware	(Philbin, 2024)
3	Quantitative	Primary school students	The use of digital content	(Anttonen et al., 2023)
4	Quantitative	Teachers of various levels	Not mentioned	(Fundi et al., 2024)
5	Quantitative	Primary school students	Digital games	(Murugiah et al., 2023)
6	Research and Development	Elementary middle school students, families, experts, representatives, education and law enforcement	Digital games	(Sripa et al., 2024)
7	Quantitative	Primary and lower secondary students	Digital competency test	(Pedaste et al., 2023)
8	Quantitative	Primary, preparatory, and secondary students	Not mentioned	(Anwar et al., 2024)
9	Quantitative (Quasi-Experiment)	Primary and secondary students	Digital games	(Zheng et al., 2024)
10	Qualitative-Exploratory	Primary school students	The use of digital content	(Wennås Brante et al., 2024)

No	Methodology	Sample	Strategies	References
11	Quantitative	Elementary, junior high, and high school maths teachers	Not mentioned	(Zulnaidi et al., 2024)
12	Mix method	Primary school students	Not mentioned	(Tai & Chen, 2024)
13	Quantitative	Primary school students	Not mentioned	(Georgiou et al., 2023)
14	Qualitative	Elementary and junior high school teachers	Not mentioned	(Seraji et al., 2023)
15	Quantitative	Elementary and junior high school students	Not mentioned	(Vit, 2023)
16	Quantitative	Primary school students	Digital competency test	(Li et al., 2024)
17	Quantitative	Year 2 students	The use of hardware	(Malpique et al., 2023)

3. Results and Discussion

3.1 Dominant Keywords in Primary School Digital Literacy after the Pandemic

The word cloud visualization method was used to address the first study question on post-pandemic research patterns, revealing an increased frequency of recurrence. Keywords were extracted from 17 relevant publications, each typically containing between three to five keywords. Figure 2 displays a compilation of 69 keywords identified in this study:

Figure 2. Keyword visualization

Noteworthy among the most frequently encountered keywords in publications were education (9 occurrences), school (7 occurrences), learning (7 occurrences), primary (5 occurrences), digital (5 occurrences), and online (5 occurrences). The next group of frequently mentioned keywords included literacy (4 occurrences), evaluation (3 occurrences), intelligence (3 occurrences), teacher (3 occurrences), and analysis (3 occurrences). From the visualized keywords, the research trends in primary school digital literacy after the pandemic were grouped into five in the following order: The first trend was education; the second was school, learning; the third was primary, digital, online; the fourth was literacy; and the fifth was evaluation, intelligence, teacher, analysis.

A search for other systematic literature review articles in the field of education from 2023 to 2024 has found three keywords related to the research trends that

have been presented. The keyword "primary education" has been found in research on cyberbullying (Chicote-Beato et al., 2024), teacher-student relationship (García-Rodríguez et al., 2023), creativity development (Potters et al., 2023), and game-based learning (Sun et al., 2023). Keyword "learning" is found in literature review articles that discuss AI in education (Chiu et al., 2023) and technology in learning (Oyetade et al., 2023). Furthermore, digital keywords include "digital games" (Esteban, 2024) and "digital literacy" (Qing & Jing, 2024).

3.2 Dominant Research Methodologies Utilized to Investigate Digital Literacy Research in Primary Schools after the Pandemic

After the pandemic, research on digital literacy in elementary schools used various research methods and approaches in data collection, including quantitative, qualitative, mixed methods, research and development. These diverse methodologies are presented visually in Figure 3:

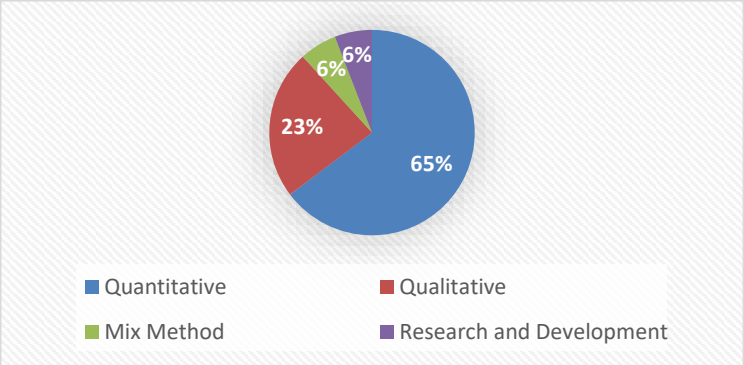

Figure 3: Method Visualization

Figure 3 shows that of the 17 studies reviewed on primary school digital literacy after the pandemic, quantitative research methodologies dominated with 11 articles (65%), and six ?researchers used qualitative methods (23%). The visualization of the research methodology presented in detail was helpful for prospective researchers to dig further into the quantitative research methods used dominantly. In addition, qualitative research methods, mixed methods, research and development were also alternatives for researchers who would research digital literacy in elementary schools after the pandemic period.

3.3 Distribution of Research Subject of Digital Literacy in Post-Pandemic Primary School

After the pandemic, research on digital literacy in elementary schools used various subjects, including teachers, students, and others. The distribution of subjects is presented visually in Figure 4:

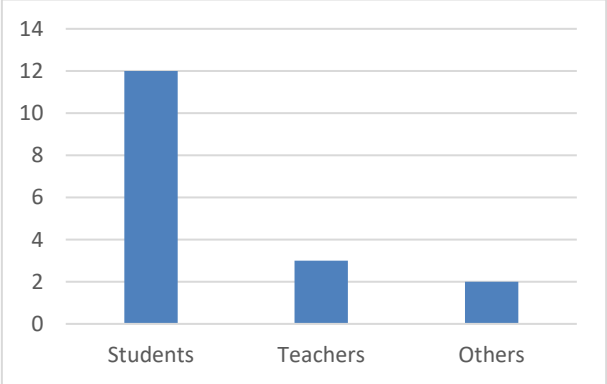

Figure 4: Distribution of Research Subject

Figure 4 shows the distribution of subjects in the field of research digital literacy in post-pandemic. The dominant subject was students (12 articles). Teachers (3 articles), and others were a combination of teacher and student research subjects (1 article), a combination of students, families, experts, education representatives, and law enforcement (1 article). An overview of the distribution of research subjects helps find gaps for future studies. Research subjects that are still rarely used may be able to increase their involvement in future studies.

3.4 Digital Literacy Strategies for Primary School Students after the Pandemic

Based on the studies reviewed, seven digital literacy strategies for primary schools after the pandemic were found: digital content, digital games, hardware use, digital competency tests, STEM, AI , and distance learning. Of these seven strategies, the first four were the most dominant. These four dominant strategies were further elaborated to obtain guidance on post-pandemic primary school digital literacy strategies.

The first strategy was the use of digital content (Anttonen et al., 2023; Jakavonytė-Staškuvienė & Ponomariovienė, 2023; Wennås Brante et al., 2024). Given the high usage of digital content, digital content was worth considering as a digital literacy strategy for primary schools. Recent data indicated that the typical worldwide user consumes 3,230 hours of digital material yearly, including 730 hours of online surfing, 894 hours of social media, 833 hours of video streaming, 566 hours of music streaming, and 207 hours of video conferencing (Istrate et al., 2024). This high rate of technology use has increased digital literacy (Qing & Jing, 2024). Digital literacy enables individuals to interpret information from digital content and perform the functions of management, judgment, and communication required for various aspects of life.

The second strategy was through digital games (Murugiah et al., 2023; Sripa et al., 2024; Zheng et al., 2024). Digital games have increased rapidly in the past two decades owing to the number of personal computers (PCs) and mobile devices worldwide (Al-Obaydi et al., 2023). Digital games and educational technology are important elements in the education system. Digital games can enhance students' learning experiences and outcomes by providing engaging intrinsic motivation (Udeozor et al., 2023). Recent studies indicate that children's access to technology, including tablets and smartphones, is rising. Furthermore, the mobile industry

has refreshed many games and instructional applications. Understanding knowledge such as maths, science, and artistic creativity is offered differently (Behnamnia et al., 2023). Digital games have elements that distinguish them from traditional learning that relies on didactic approaches. These elements include the abstraction of concepts and reality, the presence of goals, and the incorporation of conflict, competition, or cooperation to encourage social interaction and collaboration. In addition, rewards can be a strong motivator for children (Esteban, 2024).

The third strategy was the use of hardware. Research on hardware revolved around the topic of keyboard-based writing and the use of tablets. As a 21st-century skill prepared for academia and the world of work, keyboard-based writing has permeated various aspects of life and work (Gong et al., 2022; Malpique et al., 2023). Keyboard-based writing poses significant challenges for youngsters in the first stage of keyboard learning (Malpique et al., 2023). In the present educational landscape, keyboard-based writing was extensively integrated into curriculum performance criteria from the first year of schooling, and several nations have begun transitioning to online national examinations of students' reading competencies, including writing (Malpique et al., 2024).

The use of tablets has emerged as a way to enhance the digital literacy of elementary school children. Following the COVID-19 epidemic, digital resources and virtual platforms have gained paramount significance in the educational process. The use of tablets is a prominent predictor that might affect digital competence development (Guillén-Gámez et al., 2024). Using tablets in elementary education has strengthened digital literacy instruction, markedly improving the learning experience and enabling students to engage actively in knowledge construction (Philbin, 2024).

The fourth strategy was through digital competency tests. Digital competence is a fundamental competency in contemporary life. The COVID-19-induced remote education highlighted that digital competence for learning has yet to attain the anticipated standard. Consequently, it is essential to evaluate pupils' digital competency by means of exams. Empirical data collected using Digitest has initiated a discussion on assessing students' digital competence holistically and generally (Pedaste et al., 2023). In addition to using Digitest, digital information and literacy can be mapped and developed by developing a digital intelligence quotient (DQ) scale. Digital competence (DQ) is fundamentally anchored in universal moral standards and has emerged as a vital talent for people to thrive in the digital age (Li et al., 2024).

In addition to the four dominant strategies described, other strategies for implementing digital literacy for primary school students were found in the articles reviewed, namely STEM, AI, and distance learning. STEM, a holistic education system combines science, education, engineering, and mathematics, has garnered much focus in recent years owing to its critical role in equipping students for the workforce requirements of the 21st century (Anwar et al., 2024; González-Pérez & Ramírez-Montoya, 2022). The understanding of STEM is based on constructivism, in which students memorize information and interpret

information and its relation to previous knowledge, experience, and values. In this case, teachers must create a meaningful learning environment and encourage students' thinking processes (Legvart et al., 2022).

Artificial intelligence (AI) is becoming prevalent and a subject of study in Education. AI, as a machine-based system, can remember goals set by humans, predict, provide recommendations, and even provide decisions that affect the real or virtual environment (Vuorikari et al., 2022). AI systems can interact with humans, either directly or indirectly. The impact of AI has increased and penetrated more areas of life, education being no exception (Aravantinos et al., 2024). The students who belong to the digital native generation are familiar with digital technology, the Internet, and social media, presenting a challenge for teachers (Sharma, 2019). They tend to be actively involved in intelligent learning by using AI.

The last digital literacy technique examined in the analyzed research was remote education. Distance learning encompasses all educational methods that do not need the concurrent physical presence of instructors and learners in a classroom setting. Currently, remote learning is mainly facilitated by digital technologies that enable the exchange of knowledge between professors and students across many locations or time frames (Doz et al., 2023). Moving from conventional learning to online learning occurs rapidly and gives students, teachers, and parents little time to prepare for learning (Lerkkanen et al., 2023). Distance learning is described as learning that occurs at a distance between teachers and students. The media used to communicate with each other are technological instruments such as writing, audio, video, computer, and the Internet. Online learning has become mainstream nowadays (Sofi-Karim et al., 2023). The introduction of e-learning technology into education has fundamentally changed how students interact with learning materials and educational processes. E-learning technology can provide students with the capabilities and mindset required for continuous self-directed learning (Oyetade et al., 2023).

3.5 Teachers' Role in Primary School Digital Literacy after the Pandemic

Teachers have had an important role in implementing digital literacy in primary schools. Their roles included those of facilitator, curriculum implementer, collaborator, and digital content creator. Teachers, as facilitators, play a role in assisting when students experience difficulties. Although students work in groups, they tend to prefer asking teachers for help rather than their peers (Jakavonytė-Staškuvienė & Ponomariovienė, 2023). According to the criteria established by the International Society for Technology in Education (ISTE), educators use technology to enhance learning and promote attaining of ISTE standards for students. The teachers' responsibilities encompass i) cultivating a culture of student ownership regarding learning objectives and results, (ii) overseeing students' engagement with technology and learning methodologies on digital platforms, (iii) designing rigorous learning experiences for students, and(iv) demonstrating and fostering creativity and creative expression (Theodoridis & Kraemer, 2019).

As curriculum implementers, teachers are pivotal in teaching and learning, mainly when introducing a new subject (Fundi et al., 2024). The curricula that evolved owing to the pandemic have provided significant changes in the post-COVID-19 education sector, where the delivery of instruction utilizes the ability of both synchronous and asynchronous learning (Zhao & Watterston, 2021). Consequently, educators must possess digital literacy to facilitate online instruction and use contemporary and novel educational methods to cultivate digitally literate pupils (Falloon, 2020; Sánchez-Cruzado et al., 2021).

Teachers, as collaborators, need to work together with colleagues and parents. The function of teachers may enhance the development of competitive human resources and augment the efficacy of learning processes and results. Collaboration among colleagues is essential for teachers' work satisfaction, self-efficacy, and professional growth (Zulnaidi et al., 2024). Educators must also collaborate with parents to enhance digital literacy and raise knowledge of digital data protection (Akman et al., 2023). In this instance, principals must strive to ensure the sustainability of the relationship. Overall, teacher cooperation improves education outcomes and supports teacher and student well-being.

Educators may exemplify their function as digital content producers by generating and distributing concepts by means of social media. Educators must possess the ability to evaluate ideas and communication across many media critically, juxtaposition them effectively, generate original material, and modify the organization and structure creatively to meet the requirements of their audience (Seraji et al., 2023). The production of digital material requires robust software and hardware capabilities, along with sufficient digital literacy. Educators must alter/adapt? their viewpoints and methodologies beyond the mere attainment of teaching and learning competencies to mitigate the digital gap and enhance extensive social inclusion, hence promoting a sustainable society (Sá et al., 2021).

3.6 Digital Literacy Challenges for Primary Schools after the Pandemic

The integration of digital literacy in elementary education has continued to encounter obstacles. The challenge in terms of students was that there were still difficulties faced by students, namely those who have difficulty in using digital content (Jakavonytė-Staškuvienė & Ponomariovienė, 2023). Nevertheless, individuals are more inclined to seek teacher assistance than that of their peers when confronted with challenges, even while collaborating in groups. A further difficulty is that the digital competence required for learning is below the anticipated standard (Pedaste et al., 2023). Educational institutions might tackle this problem by evaluating students' digital proficiency using the digital competence assessment test for learning (Digitest). The difficulty of assessing the credibility of sources and critically interpreting the information they find is also a challenge in implementing digital literacy in primary schools (Brante et al., 2024). Collaborative initiatives in the classroom are essential to cultivating students' digital reading competencies and their capacity to evaluate online sources critically, thereby reconciling technical competency with adequate digital literacy.

Cyberbullying is one of the important challenges (Sripa et al., 2024). Therefore, it is important to provide adolescents with an understanding of cyberbullying and develop learning innovations to combat cyberbullying, one of which is learning innovations in the form of interactive games. To achieve better results, teachers should facilitate independent learning for students. The significant prevalence of children and adolescents engaging with the Internet was also a concern. Not all children and adolescents use this resource judiciously (Zheng et al., 2024). Digital literacy and Internet protocols are essential for safeguarding children and adolescents from online threats; educating them on digital ethics and Internet standards of behaviour from an early age is crucial. Digital game-based learning (DGBL) can augment student learning, motivation, and engagement.

The challenge for educators in digital literacy is the need for more training they have received on AI. Moreover, there must be professional development opportunities in AI for both pre-service and in-service educators since AI is not integrated into the curriculum (Fundi et al., 2024). First, the government must be addressed by assessing teachers' beliefs, attitudes, ethics, and subjective norms toward AI. Other significant challenges regarding teachers are the need for proper IT training, being underprepared to teach students, and infrastructure barriers (Georgiou et al., 2023). Moreover, more research on elementary school teachers' preparedness to incorporate technology is needed. Investigating the correlation between primary school teachers' ideas, attitudes, and intentions regarding self-efficacy in integrating computer-based technology into learning is essential.

4. Conclusion

This article presented a comprehensive systematic review of primary school digital literacy focused after the pandemic. This research was guided by the PRISMA model, which has been widely used. A total of 17 articles has undergone a rigorous review process. Research trends in primary school digital literacy during the pandemic revolved around five main topics based on dominant keywords, namely (i) education; (ii) school, learning; (iii) primary, digital, online; (iv) literacy; and (v) evaluation, intelligence, teacher, analysis. The dominant research methodology used in this study was the quantitative research method (65%). Other techniques used in the reviewed research were qualitative (23%), mixed method (6%), and research and development (6%). In post-pandemic primary school digital literacy implementation, there were four dominant strategies: digital content, digital games, use of hardware, and digital competency tests. Moreover, teachers' roles in post-pandemic primary school digital literacy implementation included those of facilitator, curriculum implementer, collaborator, and digital content creator.

Implementing digital literacy after the pandemic faces ongoing challenges from teachers and students. The challenge for students is that there are still difficulties in using digital content and assessing the credibility of sources and information. In addition, students' digital competence is at various levels, and there are still problems with cyberbullying. Digital literacy issues for educators include the absence of AI in teacher training curricula, insufficient information technology training, underpreparedness to instruct pupils, and infrastructural obstacles.

Furthermore, a disparity persists between the preparedness of primary school educators and the incorporation of technology in educational activities.

The theoretical implications of this literature study are to offer new insights into digital literacy, especially in elementary schools after the pandemic. Furthermore, this study's practical implications are expected to guide the government in formulating public policies. The priority of AI and ICT in the teacher training curriculum needs to be improved. In addition, the equitable distribution of learning facilities that support digital literacy also needs to be provided adequately. The practical implication for teachers from this study is that they can choose one or more of the four strategies offered in implementing digital literacy: digital content, digital games, use of hardware, and digital competency tests.

This research has limitations in the article search period, which needed longer. The year 2023 to 2024 time frame was applied in article searches based on the announcement from the WHO about the end of the pandemic period on May 5, 2023. The absence of the terms "post-COVID-19" or "post-pandemic" keywords is also a shortcoming in this literature review. Based on the findings that have been presented and the weaknesses of this study, recommendations are provided for future studies. The first recommendation is to explore the topic of digital literacy with a few keywords, namely "evaluation", "intelligence", "teacher", and "analysis". The second recommendation is to review research on digital literacy with methodologies that still need to be carried out, namely mixed method, research, and development. The third recommendation is to explore the issue of digital literacy from the perspective of teachers and students. The fourth recommendation for literature searches is to increase the search period and include the keyword "post-COVID-19".

5. Acknowledgment

The authors would like to acknowledge the financial support from the Higher Education Financing Agency (BPPT) and Indonesia Endowment Funds for Education (LPDP) with the Awardee ID Number 202209092582.

6. References

Akman, E., İdil, Ö., & Çakır, R. (2023). An investigation into the levels of digital parenting, digital literacy, and digital data security awareness among parents and teachers in early childhood education. *Participatory Educational Research*, *10*(5), 248-263. https://doi.org/10.17275/per.23.85.10.5

Al-Obaydi, L. H., Pikhart, M., & Shakki, F. (2023). Digital gaming as a panacea for incidental L2 acquisition in an EFL context. *Applied Research on English Language*, *12*(1), 73-94. https://doi.org/10.22108/ARE.2022.135344.2001

Alismaiel, O. A., Cifuentes-Faura, J., & Al-Rahmi, W. M. (2022). Online learning, mobile learning, and social media technologies: An empirical study on constructivism theory during the COVID-19 pandemic. *Sustainability (Switzerland)*, *14*(18). https://doi.org/10.3390/su141811134

Anttonen, R., Räikkönen, E., Kiili, K., & Kiili, C. (2023). Sixth graders evaluating online texts: Self-efficacy beliefs predict confirming but not questioning the credibility. *Scandinavian Journal of Educational Research*, 1-17. https://doi.org/10.1080/00313831.2023.2228834

Anwar, R., Elbashir, A. M., Magdy, R., Ahmad, Z., & Al-Thani, N. J. (2024). Effectiveness

of STEM based workshop for deaf education: Exploratory study. *Heliyon*, *10*(16), e36012. https://doi.org/10.1016/j.heliyon.2024.e36012

Aravantinos, S., Lavidas, K., Voulgari, I., Papadakis, S., Karalis, T., & Komis, V. (2024). Educational approaches with AI in primary school settings: A systematic review of the literature available in Scopus. *Education Sciences*, *14*(7), 744. https://doi.org/10.3390/educsci14070744

Behnamnia, N., Kamsin, A., Ismail, M. A. B., & Hayati, S. A. (2023). A review of using digital game-based learning for preschoolers. *Journal of Computers in Education, 10*(4). Springer Berlin Heidelberg. https://doi.org/10.1007/s40692-022-00240-0

Bordoloi, R., Das, P., & Das, K. (2021). Perception towards online/blended learning at the time of COVID-19 pandemic: An academic analytics in the Indian context. *Asian Association of Open Universities Journal*, *16*(1), 41-60. https://doi.org/10.1108/AAOUJ-09-2020-0079

Charrois, T. L. (2015). Systematic reviews: What do you need to know to get started? *Canadian Journal of Hospital Pharmacy*, *68*(2), 144-148. https://doi.org/10.4212/cjhp.v68i2.1440

Chicote-Beato, M., González-Víllora, S., Bodoque-Osma, A. R., & Navarro, R. (2024). Cyberbullying intervention and prevention programmes in primary education (6 to 12 years): A systematic review. *Aggression and Violent Behavior*, *77*(January). https://doi.org/10.1016/j.avb.2024.101938

Chiu, T. K. F., Xia, Q., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, *4*(November 2022), 100118. https://doi.org/10.1016/j.caeai.2022.100118

Doz, E., Cuder, A., Caputi, M., Pellizzoni, S., & Passolunghi, M. C. (2023). Distance learning environment: Perspective of Italian primary and secondary teachers during COVID-19 pandemic. *Learning Environments Research*, *26*(2), 555-571. https://doi.org/10.1007/s10984-022-09451-9

Esteban, A. J. (2024). Theories, principles, and game elements that support digital game-based language learning (DGBLL): A systematic review. *International Journal of Learning, Teaching and Educational Research*, *23*(3), 1-22. https://doi.org/10.26803/ijlter.23.3.1

Falloon, G. (2020). From digital literacy to digital competence: The teacher digital competency (TDC) framework. *Educational Technology Research and Development*, *68*(5), 2449-2472. https://doi.org/10.1007/s11423-020-09767-4

Fundi, M., Sanusi, I. T., Oyelere, S. S., & Ayere, M. (2024). Advancing AI education: Assessing Kenyan in-service teachers' preparedness for integrating artificial intelligence in competence-based curriculum. *Computers in Human Behavior Reports*, *14*(January), 100412. https://doi.org/10.1016/j.chbr.2024.100412

García-Rodríguez, L., Iriarte Redín, C., & Reparaz Abaitua, C. (2023). Teacher-student attachment relationship, variables associated, and measurement: A systematic review. *Educational Research Review*, *38*(August 2022), 100488. https://doi.org/10.1016/j.edurev.2022.100488

Georgiou, D., Trikoili, A., & Kester, L. (2023). Rethinking determinants of primary school teachers' technology acceptance during the COVID-19 pandemic. *Computers and Education Open*, *4*(June), 100145. https://doi.org/10.1016/j.caeo.2023.100145

Gong, T., Zhang, M., & Li, C. (2022). Association of keyboarding fluency and writing performance in online-delivered assessment. *Assessing Writing*, *51*(February 2021), 100575. https://doi.org/10.1016/j.asw.2021.100575

González-Pérez, L. I., & Ramírez-Montoya, M. S. (2022). Components of Education 4.0 in 21st century skills frameworks: Systematic review. *Sustainability (Switzerland)*, *14*(3), 1-31. https://doi.org/10.3390/su14031493

Guillén-Gámez, F. D., Colomo-Magaña, E., Cívico-Ariza, A., & Linde-Valenzuela, T.

(2024). Which is the digital competence of each member of educational community to use the computer? Which predictors have a greater influence? *Technology, Knowledge and Learning*, *29*(1), 1-20. https://doi.org/10.1007/s10758-023-09646-w

Istrate, R., Tulus, V., Grass, R. N., Vanbever, L., Stark, W. J., & Guillén-Gosálbez, G. (2024). The environmental sustainability of digital content consumption. *Nature Communications*, *15*(1), 1-11. https://doi.org/10.1038/s41467-024-47621-w

Jakavonytė-Staškuvienė, D., & Ponomariovienė, J. (2023). Competency-based practice in conducting natural science research and presenting its results in primary classes: A case study. *Cogent Education*, *10*(2). https://doi.org/10.1080/2331186X.2023.2267962

Legvart, P., Aberšek, M. K., & Kerneža, M. (2022). Developing communication competence in digital learning environments for primary science students. *Journal of Baltic Science Education*, *21*(5), 836-848. https://doi.org/10.33225/jbse/22.21.836

Lerkkanen, M. K., Pakarinen, E., Salminen, J., & Torppa, M. (2023). Reading and math skills development among Finnish primary school children before and after COVID-19 school closure. *Reading and Writing*, *36*(2), 263-288. https://doi.org/10.1007/s11145-022-10358-3

Li, J., Ju, S.-Y., Zhu, C., Yuan, Y., Fu, M., Kong, L.-K., & Li, M. (2024). The development of a digital intelligence quotient scale: A new measuring instrument for primary school students in China. *Heliyon*, *10*(16), e36437. https://doi.org/10.1016/j.heliyon.2024.e36437

Li, M., & Yu, Z. (2022). Teachers' satisfaction, role, and digital literacy during the COVID-19 pandemic. *Sustainability (Switzerland,)* *14*(3). https://doi.org/10.3390/su14031121

Malpique, A. A., Valcan, D., Pino-Pasternak, D., Ledger, S., Asil, M., & Teo, T. (2023). The keys of keyboard-based writing: Student and classroom-level predictors of keyboard-based writing in early primary. *Contemporary Educational Psychology*, *75*(September), 102227. https://doi.org/10.1016/j.cedpsych.2023.102227

Malpique, A., Pino-Pasternak, D., Ledger, S., Valcan, D., & Asil, M. (2024). The effects of automaticity in paper and keyboard-based text composing: An exploratory study. *Computers and Composition*, *72*(April), 102848. https://doi.org/10.1016/j.compcom.2024.102848

Moher, (2015). Preferred reporting items for systematic review and meta-analysis protocols (prisma-p) 2015 statement. *Japanese Pharmacology and Therapeutics*, *47*(8), 1177-1185. https://doi.org/https://doi.org/10.1186/2046-4053-4-1

Murugiah, L., Ismail, R., Taib, H. M., Applanaidu, S. D., & Long, M. N. H. B. H. (2023). Children's understanding of financial literacy and parents' choice of financial knowledge learning methods in Malaysia. *MethodsX*, *11*(August). https://doi.org/10.1016/j.mex.2023.102383

Nogueira, V. B., Teixeira, D. G., De Lima, I. A. C. N., Moreira, M. V. C., De Oliveira, B. S. C., Pedrosa, I. M. B., De Queiroz, J. W., & Jeronimo, S. M. B. (2022). Towards an inclusive digital literacy: An experimental intervention study in a rural area of Brazil. *Education and Information Technologies*, *27*(2), 2807-2834. https://doi.org/10.1007/s10639-021-10711-z

Nwosu, L. I., Matashu, M., & Buabeng, A. T. (2022). A call to strengthen instructional leadership to support learner achievement during and post COVID-19: A systematic literature review approach. *International Journal of Learning, Teaching and Educational Research*, *21*(7), 219-240. https://doi.org/10.26803/ijlter.21.7.12

Ogbonnaya, U. I., Awoniyi, F. C., & Matabane, M. E. (2020). Move to online learning during COVID-19 lockdown: Pre-service teachers' experiences in Ghana. *International Journal of Learning, Teaching and Educational Research*, *19*(10), 286-303. https://doi.org/10.26803/IJLTER.19.10.16

Oyetade, K., Harmse, A., & Zuva, T. (2023). Factors influencing students' use of e-learning technologies. *International Journal of Learning, Teaching and Educational Research*, *22*(9), 617-632. https://doi.org/10.26803/ijlter.22.9.33

Pedaste, M., Kallas, K., & Baucal, A. (2023). Digital competence test for learning in schools: Development of items and scales. *Computers and Education*, *203*(May), 104830. https://doi.org/10.1016/j.compedu.2023.104830

Philbin, C. A. (2024). Beyond apps: Tablet and micro:bit devices as tools for creative computing in primary schools. *ACM International Conference Proceeding Series*, 25-28. https://doi.org/10.1145/3633053.3633054

Potters, O. T. A., Van Schijndel, T. J. P., Jak, S., & Voogt, J. (2023). Two decades of research on children's creativity development during primary education in relation to task characteristics. *Educational Research Review*, *39*(March), 100532. https://doi.org/10.1016/j.edurev.2023.100532

Qazi, A., Qazi, J., Naseer, K., Zeeshan, M., Qazi, S., Abayomi-Alli, O., Said Ahmad, I., Darwich, M., Ali Talpur, B., Hardaker, G., Naseem, U., Yang, S., & Haruna, K. (2021). Adaption of distance learning to continue the academic year amid COVID-19 lockdown. *Children and Youth Services Review*, *126*(October 2020), 106038. https://doi.org/10.1016/j.childyouth.2021.106038

Qing, X., & Jing, G. (2024). Digital literacy in a global context: constructing models for international Chinese teachers across regions and countries. *International Journal of Learning, Teaching and Educational Research*, *23*(7), 539-561. https://doi.org/10.26803/ijlter.23.7.27

Sá, M. J., Santos, A. I., Serpa, S., & Miguel Ferreira, C. (2021). Digitainability—Digital competences post-COVID-19 for a sustainable society. *Sustainability*, *13*(17), 9564. https://doi.org/10.3390/su13179564

Sánchez-Cruzado, C., Santiago Campión, R., & Sánchez-Compaña, M. T. (2021). Teacher digital literacy: The indisputable challenge after COVID-19. *Sustainability (Switzerland)*, *13*(4). https://doi.org/10.3390/su13041858

Seraji, F., Malmir, R., Kasani, H. A., & Abedi, H. (2023). Teacher-generated content in social media: Studying the experience of Iranian teachers. *Teaching and Teacher Education*, *121*, 103955. https://doi.org/10.1016/j.tate.2022.103955

Sharma, P. (2019). Digital revolution of education 4.0. *International Journal of Engineering and Advanced Technology*, *9*(2), 3558-3564. https://doi.org/10.35940/ijeat.a1293.129219

Sofi-Karim, M., Bali, A. O., & Rached, K. (2023). Online education via media platforms and applications as an innovative teaching method. *Education and Information Technologies*, *28*(1), 507-523. https://doi.org/10.1007/s10639-022-11188-0

Sripa, K., Thummaphan, P., Ninphet, T., & Gulabutr, V. (2024). Combating cyberbullying in Thai youth: Learning innovation as a possible solution. *International Journal of Educational Development*, *108*(June), 103065. https://doi.org/10.1016/j.ijedudev.2024.103065

Sun, L., Kangas, M., Ruokamo, H., & Siklander, S. (2023). A systematic literature review of teacher scaffolding in game-based learning in primary education. *Educational Research Review*, *40*(May), 100546. https://doi.org/10.1016/j.edurev.2023.100546

Sydorenko, V. V, Akhnovska, I. O., Smirnov, S. V, Verbovskyi, I. A., & Melnychuk, O. V. (2024). Improvement of higher education: How to bridge the digital divide during the transformation ? *Journal of Eductaion and Learning (EduLearn), 18*(3). https://doi.org/10.11591/edulearn.v18i3.21078

Tabieh, A. A. S., Hamzeh, M., Abu-Foudeh, B. K. S., Jarrar, N., Al-Manaseer, S., Al-Shawabkeh, A., & Seikaly, R. (2021). Digital literacy and its acquisition by teachers and principals at educational workplaces. *International Journal of Learning, Teaching and Educational Research*, *20*(5), 38-55. https://doi.org/10.26803/ijlter.20.5.3

Tai, T. Y., & Chen, H. H. J. (2024). Improving elementary EFL speaking skills with generative AI chatbots: Exploring individual and paired interactions. *Computers and Education*, *220*(March), 105112. https://doi.org/10.1016/j.compedu.2024.105112

Tarkar, P. (2021). Impact of COVID-19 pandemic on education system. *International Journal of Environmental Economics, Commerce and Educational Management*, 6–8. https://doi.org/10.36713/epra6363The journal was published before the article was written?

Taskin, B., & Ok, C. (2022). Impact of digital literacy and problematic smartphone use on life satisfaction: Comparing pre- and post-COVID-19 pandemic. *European Journal of Investigation in Health, Psychology and Education*, *12*(9), 1311-1322. https://doi.org/10.3390/ejihpe12090091

Theodoridis, T., & Kraemer, J. (2019). *ISTE Standards*. https://iste.org/standards

Udeozor, C., Russo-Abegão, F., & Glassey, J. (2023). Perceptions and factors affecting the adoption of digital games for engineering education: A mixed-method research. *International Journal of Educational Technology in Higher Education*, *20*(1). https://doi.org/10.1186/s41239-022-00369-z

Vit, E. (2023). The ability of low- and high-SES schools to inhibit learning losses during the COVID-19 pandemic. *Social Sciences and Humanities Open*, *7*(1), 100393. https://doi.org/10.1016/j.ssaho.2022.100393

Vuorikari, R., Kluzer, S., & Punie, Y. (2022). DigComp 2.2. The digital competence framework for citizens. With new examples of knowledge, skills and attitudes. *Publications Office of the European Union* https://doi.org/10.2760/115376

Wennås Brante, E., Walldén, R., & Ridell, K. (2024). Eight-year-olds engaging in guided information searches with iPads: Dimensions of reading competence. *International Journal of Child-Computer Interaction*, *40*(May). https://doi.org/10.1016/j.ijcci.2024.100658

Yu, Z. (2022). Sustaining student roles, digital literacy, learning achievements, and motivation in online learning environments during the COVID-19 pandemic. *Sustainability (Switzerland)*, *14*(8). https://doi.org/10.3390/su14084388

Zhao, Y., & Watterston, J. (2021). The changes we need: Education post COVID-19. *Journal of Educational Change*, *22*(1), 3-12. https://doi.org/10.1007/s10833-021-09417-3

Zheng, Y., Zhang, J., Li, Y., Wu, X., Ding, R., Luo, X., Liu, P., & Huang, J. (2024). Effects of digital game-based learning on students' digital etiquette literacy, learning motivations, and engagement. *Heliyon*, *10*(1), e23490. https://doi.org/10.1016/j.heliyon.2023.e23490

Zulnaidi, H., Mafarja, N., Rahim, S. S. A., & Salleh, U. K. M. (2024). Ethical mediation: The influence of mathematics teachers cooperation on readiness for the industrial revolution era in Indonesia and Malaysia. *Acta Psychologica*, *243*(November 2023 The journal was published before the article was written?), 104151. https://doi.org/10.1016/j.actpsy.2024.104151