Digital Literacy Transformation in Science Learning: Teacher Adaptation in the Independent Curriculum Era

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ABSTRACT. The development of digital technology has brought significant changes to educational practices, including science learning. Teachers are required not only to deliver material but also to act as facilitators capable of utilizing digital devices, e-learning platforms, and interactive learning resources to improve learning effectiveness. The purpose of this study is to analyze the transformation of digital literacy in science learning by emphasizing teacher adaptation strategies in the Merdeka Curriculum era. This study used a literature study method by reviewing scientific articles, books, and research reports from the last five years relevant to the topic of digital literacy and science education. The analysis was conducted descriptively and qualitatively to identify patterns, challenges, and teacher adaptation strategies in integrating technology into the classroom. The results of the study indicate that teachers with high levels of digital literacy are better able to design innovative learning, increase student engagement, and support the achievement of the Pancasila learner profile. However, the study also found obstacles such as limited infrastructure, variations in teacher competencies, and resistance to pedagogical change. The conclusion of this study confirms that digital literacy transformation is an urgent need in science learning and that teacher adaptation is a key factor in the successful implementation of the Merdeka Curriculum.

Keywords: digital literacy; science learning; Independent Curriculum.

INTRODUCTION

The development of digital technology in the 21st century has had a profound impact on the education system, particularly in science learning. This shift requires teachers not only to master subject content but also to possess sufficient digital literacy to effectively integrate technology into the learning process. Digital literacy is understood as the ability to access, understand, evaluate, and utilize information through digital devices effectively and ethically (setiawan & kurniawati, 2020). In the context of science education, digital literacy serves as a crucial foundation since science is closely related to technological dynamics and global information developments (mulyono, 2021).

The urgency of mastering digital literacy becomes even more evident when associated with the *kurikulum merdeka* policy. This curriculum promotes project-based learning, differentiation, and student independence, thus requiring teachers to act as facilitators as well as innovators in managing technology-based learning (hakim & sari, 2022). Therefore, teachers are expected to adapt their teaching strategies to meet the needs of students who are increasingly immersed in the digital world.

The research problem in this study focuses on how the transformation of digital literacy influences science learning and how teachers adapt their strategies in implementing digital

technology during the *kurikulum merdeka* era. The main focus of this research is to identify patterns, challenges, and adaptation strategies of teachers in optimizing digital literacy to improve the quality of science learning in schools. The purpose of this study is to critically analyze literature discussing digital literacy, teacher adaptation, and science learning, while emphasizing their practical contribution to the implementation of *kurikulum merdeka* (susanto & pratami, 2023).

Previous studies have shown that the use of digital technology in science learning can enhance student participation, foster collaboration, and strengthen conceptual understanding (nugraha & rahman, 2021). Other research highlights that teachers with higher digital competence tend to design blended learning and e-learning models that are more relevant to students' needs (putra & wahyuni, 2020). However, limitations in infrastructure, lack of teacher training, and resistance to change remain challenges in implementing digital literacy in schools (wulandari & ramadhan, 2022).

The identified research gap lies in the limited number of conceptual studies that specifically connect digital literacy transformation with teacher adaptation within the *kurikulum merdeka* framework. Most previous studies have focused on the use of learning technologies but have not comprehensively addressed teacher adaptation strategies in responding to the demands of the new curriculum (handoko & nisa, 2021). Therefore, this study aims to provide an in-depth literature analysis of the teacher's role as an agent of digital literacy transformation in science education.

The scientific contribution of this study lies in presenting a critical synthesis of teacher digital literacy, pedagogical adaptation, and their relevance to the *kurikulum merdeka*. This study not only emphasizes the importance of digital skills for teachers but also provides practical directions for developing more adaptive and innovative learning strategies. Thus, this article is expected to enrich academic discourse while offering concrete recommendations for teachers, curriculum developers, and policymakers to optimize the digital literacy transformation in science education (mahmudah, 2022).

METHOD

This study employed a qualitative approach using a literature study design. The literature study was chosen because the main objective of this research is to critically analyze existing literature on digital literacy, science learning, and teacher adaptation within the context of the *kurikulum merdeka*. A literature study allows the researcher to synthesize findings from previous studies to identify patterns, themes, and relevant scientific contributions (nugroho, 2019).

Data sources

the data sources of this study were drawn from nationally accredited (sinta) journals, reputable international journals, academic books, and conference proceedings published within the last five years. This time range was selected to ensure the data's relevance and currency. Articles were selected using keywords such as *digital literacy*, *science learning*, *teacher adaptation*, and *kurikulum merdeka* (ardiyansyah & fitriani, 2021).

Data collection techniques

data collection was carried out through a systematic search in databases such as google scholar, doaj, garuda, and researchgate. The inclusion criteria consisted of articles explicitly discussing digital literacy in the context of science education or teacher adaptation during the *kurikulum merdeka* era. The exclusion criteria were articles deemed irrelevant or opinion-based without scientific evidence (indrawan, 2020).

Data analysis techniques

the data were analyzed using content analysis. The analytical stages included data reduction, categorization, synthesis, and conclusion drawing (miles, huberman, & saldaña, 2018). In the data

reduction stage, relevant information from selected articles was identified. This information was then categorized into key themes such as the contribution of digital literacy, challenges in teacher adaptation, and its relevance to the *kurikulum merdeka*. The synthesis process followed, where patterns and interconnections between themes were identified, leading to conclusions that address the study's research questions.

Data validity

the validity of the data was ensured through source triangulation. Data were compared across various types of literature to confirm consistency in the findings. Furthermore, the credibility of the data was reinforced by selecting sources from peer-reviewed journals and reputable academic publishers (moleong, 2021). Hence, the research results can be scientifically justified and possess strong validity.

RESULT AND DISCUSSION

Result

The literature review conducted on more than 30 articles, books, and conference proceedings published within the last five years resulted in three main findings: (1) digital literacy plays a significant role in improving the quality of science learning, (2) teachers' adaptation to digital literacy faces both internal and external challenges, and (3) the *Kurikulum Merdeka* provides a policy framework that supports the transformation toward digital-based learning.

Table 1 Summary of Key Research Findings on STEAM

No.	Focus of Study	Key Findings	Source
1	Digital literacy	Improve student conceptual understanding, participation, and collaboration	(Wahyuni & Rosyid, 2021)
2	Teacher adaptation	Teachers have limited digital competence, still resistant to traditional methods	(Zubaidah & Kurniawan, 2020)
3	Independent Curriculum	Supporting project-based learning and technology	(Andayani & Hidayat, 2022)

The results of this study confirm that digital literacy is not just an additional skill, but an important foundation in the transformation of science learning.

Discussion

Digital Literacy as a Reinforcer of Science Learning

Digital literacy has been proven to enhance student engagement in science learning. Teachers who can integrate digital technologies—such as virtual simulations, interactive videos, or online laboratory applications—successfully create more engaging and meaningful learning experiences (Ismail & Lestari, 2021). This aligns with constructivist theory, which emphasizes that students build understanding through direct experiences using digital media (Supriyadi, 2019). Compared to conventional methods, the use of digital technology encourages students to be more active and critical. They not only receive information but also explore, analyze, and produce new knowledge through various digital platforms (Hartono & Fadilah, 2021). These findings reinforce

international research that highlights the importance of digital literacy in shaping 21st-century skills (Anderson & Pitts, 2020).

Challenges in Teachers' Adaptation to Digital Literacy

Although digital literacy has positive effects, teachers face several challenges in adapting to it. The first challenge is the limitation of digital competence, which remains a major obstacle. Many teachers are not yet familiar with using learning applications or still struggle to design interactive digital media (Rahardjo & Putri, 2022). The second challenge concerns infrastructural limitations in schools, especially in regions with minimal access to technology, which leads to uneven implementation of digital literacy (Kurniasih & Pratama, 2021). In addition, there is resistance to pedagogical change some teachers prefer traditional lecture-based methods because they are considered easier to apply (Zubaidah & Kurniawan, 2020). However, a paradigm shift in teaching is essential to meet the learning characteristics of digital-native students (Mulyono, 2021). Therefore, continuous training and strong institutional policy support are crucial for improving teachers' digital competence.

Relevance of Digital Literacy to the *Kurikulum Merdeka* The *Kurikulum Merdeka*

emphasizes project- based learning that connects students with real-world problems. In this regard, digital literacy strengthens implementation by allowing students to access information, collaborate, and present results through digital media (Hakim & Sari, 2022). Teachers play a vital role in designing projects that not only focus on scientific content but also incorporate digital tools. Research shows that when teachers effectively utilize digital literacy, students become more independent and are able to produce tangible outcomes relevant to daily life (Anisa & Prasetyo, 2021). Thus, digital literacy not only supports learning achievement but also embodies the core values of the *Kurikulum Merdeka*, particularly in developing the *Profil Pelajar Pancasila*.

Scientific Contribution of the Study

The scientific contribution of this study lies in its critical synthesis emphasizing the importance of digital literacy as a key factor in transforming science learning. Unlike previous studies that mainly focused on technology use, this research highlights the teacher's role as an agent of transformation. By situating the *Kurikulum Merdeka* as the policy framework, this study provides a new perspective on how digital literacy can be implemented more systematically within schools.

CONCLUSION

This study concludes that digital literacy serves as a fundamental pillar in the transformation of science learning in the *Kurikulum Merdeka* era. The results of the literature review affirm that digital literacy enhances students' conceptual understanding, participation, and 21st-century skills. Teachers play a strategic role as agents of transformation; however, their adaptation is still constrained by limited competence, inadequate infrastructure, and pedagogical resistance. The *Kurikulum Merdeka* provides broad opportunities for integrating digital literacy through project-based learning that emphasizes student independence and creativity.

Thus, the implication of this research is the need to strengthen teacher capacity through digital literacy training, provide adequate supporting facilities, and ensure consistent educational policies. The scientific contribution of this study lies in its synthesis of literature that underscores digital literacy transformation as not merely a global demand but a concrete necessity for improving the quality of science education in Indonesia.

BIBLIOGRAPHY

Andayani, S., & Hidayat, R. (2022). Literasi digital guru dalam konteks Kurikulum Merdeka. *Jurnal Pendidikan Nasional*, 13(2), 177–188.

Anderson, M., & Pitts, C. (2020). Creativity and innovation in STEAM education. *Journal of Science Education Research*, 15(2), 87–98.

Anisa, F., & Prasetyo, D. (2021). Adaptasi guru terhadap literasi digital dalam pembelajaran IPA. *Jurnal Inovasi Pendidikan IPA*, 9(1), 67–78.

Ardiyansyah, R., & Fitriani, L. (2021). Strategi penelusuran literatur akademik pada database digital. *Jurnal Kepustakaan Indonesia*, 7(1), 33–42.

Hakim, L., & Sari, D. (2022). Adaptasi guru terhadap Kurikulum Merdeka: Perspektif literasi digital. *Jurnal Pendidikan Indonesia*, 11(3), 201–213.

Handoko, T., & Nisa, R. (2021). Tantangan implementasi literasi digital dalam kurikulum baru. *Jurnal Ilmu Pendidikan Indonesia*, 9(2), 145–157.

Hartono, S., & Fadilah, N. (2021). Guru sebagai agen transformasi pendidikan digital. *Jurnal Ilmu Pendidikan*, 11(3), 201–210.

Indrawan, A. (2020). Teknik penelusuran literatur dalam studi pustaka. *Jurnal Penelitian Sosial Humaniora*, 5(2), 145–156.

Ismail, T., & Lestari, D. (2021). Literasi digital dalam pembelajaran sains. *Jurnal Pendidikan Sains Indonesia*, 12(1), 55–66.

Kurniasih, T., & Pratama, A. (2021). Kesenjangan fasilitas pendidikan dalam implementasi literasi digital. *Jurnal Inovasi Pendidikan Sains*, 9(2), 133–144.

Mahmudah, F. (2022). Literasi digital guru dan inovasi pembelajaran. *Jurnal Teknologi Pendidikan*, 14(1), 99–110.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2018). *Qualitative data analysis: A methods sourcebook*. Thousand Oaks, CA: Sage Publications.

Moleong, L. J. (2021). *Metodologi penelitian kualitatif*. Bandung: Remaja Rosdakarya.

Mulyono, H. (2021). Literasi digital dalam pembelajaran sains. *Jurnal Pendidikan Sains*, 12(2), 155–167.

Nugraha, Y., & Rahman, A. (2021). Teknologi digital dan kolaborasi dalam pembelajaran IPA. *Jurnal Inovasi Pendidikan IPA*, 7(1), 45–56.

Nugroho, Y. (2019). *Metode penelitian kepustakaan*. Yogyakarta: Deepublish.

Rahardjo, B., & Putri, A. (2022). Kompetensi pedagogis digital guru di era abad 21. *Jurnal Teknologi Pendidikan*, 14(2), 122–134.

Supriyadi, E. (2019). Teori konstruktivisme dalam pendidikan modern. *Jurnal Pendidikan Humaniora*, 8(2), 88–97.

Susanto, R., & Pratami, I. (2023). Literasi digital guru dan pembelajaran abad 21. *Jurnal Pendidikan Nasional*, 15(1), 33–44.

Sutrisno, A. (2020). Konsep dasar literasi digital. *Jurnal Teknologi Informasi Pendidikan*, 10(1), 45–57.

Wahyuni, L., & Rosyid, A. (2021). Pengaruh literasi digital terhadap hasil belajar IPA. *Jurnal Pendidikan IPA Indonesia*, 10(2), 155–165.

Wulandari, S., & Ramadhan, A. (2022). Hambatan guru dalam mengintegrasikan literasi digital. *Jurnal Ilmu Pendidikan Humaniora*, 10(3), 233–244.

Zubaidah, U., & Kurniawan, D. (2020). Hambatan adaptasi guru terhadap literasi digital. *Jurnal Pendidikan Humaniora*, 9(1), 99–110.