Al-Ishlah: Jurnal Pendidikan
Vol.16, 4 (December, 2024), pp. 5794-5804
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v16i4.5619

Assessing Teacher Competency and Preparedness for Integrating Digital Media in 21st-Century Education: An Exploratory Review

Lailan Aprina Siregar[1], Surianti Siregar[2]

[1] STAI Barumun Raya Sibuhuan, Indonesia; lailanaprina9@gmail.com
[2] STIT Padang Lawas Gunungtua, Indonesia; siregarsurianti81@gmail.com

ARTICLE INFO

Keywords:
Applying;
Digital Media;
Teacher Competency

Article history:
Received 2024-07-02
Revised 2024-09-20
Accepted 2024-12-30

ABSTRACT

The integration of digital media in 21st-century education is critical, yet understanding teacher competency and readiness remains a challenge. This study investigates teacher digital literacy, readiness, and barriers to integrating digital media in education, proposing actionable strategies for improvement. A qualitative multi-case study design was employed. Data were collected through semi-structured interviews, focus group discussions, and document analysis with 30 teachers from SMK N 1 Lubuk Barumun, selected via purposive sampling to ensure diverse representation. Thematic analysis was conducted to identify patterns and insights. Findings reveal significant disparities in digital literacy levels, influenced by individual teaching experiences. Many teachers lack essential digital skills and confidence, while professional development programs often emphasize theory over practical application. Infrastructure inadequacies and limited institutional support further hinder effective digital media integration. However, access to resources and fostering a collaborative culture within schools significantly enhance implementation efforts. These findings highlight the necessity of a multifaceted approach to bridge the competency gap. This includes targeted professional development, infrastructural investment, and fostering institutional support to empower educators in rural and urban settings. The study concludes that addressing the barriers to digital media integration requires comprehensive efforts at multiple levels. Future research should focus on hands-on training programs for educators in rural schools and scalable infrastructural solutions to enhance digital literacy. This study contributes to the broader discourse on leveraging institutional support to overcome digital literacy challenges in education.

Corresponding Author:

Lailan Aprina Siregar
STAI Barumun Raya Sibuhuan, Indonesia; lailanaprina9@gmail.com

1. INTRODUCTION

The rapid advancement of technology has significantly reshaped education in the 21st century. Digital media, encompassing various tools and platforms, has become integral to modern teaching and learning processes (Jamiah et al., 2019). This transformation necessitates that educators not only possess traditional pedagogical skills but also the competencies to effectively integrate digital media into their classrooms (Rafiola et al., 2020). However, the extent to which teachers are prepared for this digital shift varies, posing both challenges and opportunities within contemporary educational systems (Lyman et al., 2023).

One significant issue is the gap in teacher competency and readiness to adopt digital media. Many educators face challenges in effectively utilizing these tools due to insufficient training and resources, which can lead to inconsistent implementation and potentially exacerbate educational inequalities (Falloon, 2020). This issue is further complicated by disparities in access to technology across regions and institutions, underscoring the need for a comprehensive understanding of teacher readiness and competency in using digital media (Al-Samarraie et al., 2020). The core challenge lies in how these issues specifically hinder the effective integration of digital media in classrooms. Teachers' competency in integrating digital media significantly influences teaching effectiveness and student engagement. Educators with higher digital literacy tend to use digital tools, such as interactive learning software or online platforms, to foster a more dynamic and engaging learning environment (Sriekaningsih et al., 2019). In contrast, teachers with lower digital competence may limit their use of technology to simple tasks, such as displaying materials without interactive elements, which leads to less engaged students who fail to fully benefit from the potential of these tools. This disparity in teacher competency can result in inequalities in student outcomes, where students taught by digitally proficient teachers are more likely to be engaged and perform well, while those in classrooms with less digitally adept teachers may struggle academically and technologically, which impacts their future prospects.

Despite a growing body of research on technology in education, there remains a gap in understanding the specific competencies required for teachers to effectively use digital media and the extent of their preparedness (Almeida & Simoes, 2019). Previous studies have often emphasized the availability of technology and its potential benefits rather than the preparedness and competency of educators in integrating these tools into their teaching practices (Ramlah et al., 2022). This research aims to address this gap by examining teacher competency and readiness to apply digital media in 21st-century education (Sebsibe et al., 2023). The novelty of this study lies in its comprehensive exploration of the competencies required for effective digital media integration, focusing on the readiness of teachers to implement these tools in their classrooms. By synthesizing existing literature and identifying key areas for improvement, this study provides a holistic view of the challenges and opportunities that educators face in the digital age. What sets this research apart is its in-depth focus on teacher readiness, particularly in terms of digital literacy and institutional support (Sigit Gesang Permana et al., 2022). It also offers a broader analysis by exploring the barriers teachers encounter, including lack of confidence and insufficient professional development support. Through a multi-case approach, this study provides concrete insights into how teacher readiness affects the integration of digital media, especially in schools with limited infrastructure.

The primary goal of this research is to assess the current competency levels and readiness of teachers to use digital media, identify barriers to effective implementation, and propose strategies to enhance teacher preparedness. The study aims to highlight best practices and provide recommendations for policymakers and educational institutions to better support teachers in this digital transition. The anticipated outcomes of this research include a deeper understanding of teachers' professional development needs, improved strategies for integrating digital media into teaching practices, and, ultimately, enhanced educational outcomes for students. This study seeks to contribute to the development of more effective and inclusive educational practices in the digital era by addressing the gaps in teacher competency and readiness. This study's findings can be used by education policymakers to design targeted digital training programs that address teachers' specific needs,

ensuring a balance between technical skills and pedagogical strategies. Additionally, schools can enhance teacher digital readiness by implementing mentorship programs, providing ongoing professional development, and fostering a culture of collaboration and innovation in the use of technology.

2. METHOD

This research uses a qualitative methodology with a multi-case study design to explore teacher competency and readiness to implement digital media in 21st-century education. A qualitative approach allows an in-depth understanding of teachers' experiences, perceptions, and challenges in integrating digital media into their teaching practices (Miles et al., 2018). Utilizing a multi-case study design, this research compares and contrasts findings across different educational contexts, comprehensively analyzing the phenomenon. The multiple-case study design is well suited to this research because it allows for a more in-depth and comprehensive exploration of variations in teacher experiences and readiness across educational contexts. By comparing cases from urban and rural schools and public and private institutions, this study can identify factors that influence teacher competency and readiness in implementing digital media, both locally and contextually. This design also provides flexibility in exploring differences and similarities across cases, making the research results richer and more applicable to a variety of educational settings.

This study utilized semi-structured interviews, focus group discussions, and document analysis as data collection techniques. Semi-structured interviews with teachers provided in-depth insights into their competence, readiness, and experiences with digital media integration. Focus group discussions facilitated the exploration of shared experiences and collective perspectives, while analyzing training materials, curriculum guidelines, and policy documents contextualized findings within the broader educational framework.

Purposive sampling was employed to select 30 informants, ensuring diverse representation from urban and rural schools, public and private institutions, and various levels of education. Data were analyzed using thematic analysis, which involved systematically coding and categorizing data to identify key themes and patterns related to teacher competency and readiness. Initial codes were generated by thoroughly reviewing transcripts to identify recurring keywords, phrases, and concepts. These codes were then grouped into broader categories to uncover significant themes. Deductive coding guided the analysis when relevant theories or frameworks applied to specific aspects of the data.

Triangulation validated findings by integrating data from interviews, focus groups, and document analysis. This approach ensured that conclusions reflected diverse teacher experiences and mitigated biases inherent in individual data sources. Focus group discussions, comprising 6–8 participants per group, were stratified based on educational settings (urban, rural, public, private) and teacher experience levels (early-career and experienced). This stratification allowed for balanced representation and a nuanced exploration of perspectives on digital media integration. Triangulating multiple data sources enhanced the internal validity and credibility of the study's findings by uncovering consistent patterns and addressing inconsistencies.

3. FINDING AND DISCUSSION

This study revealed a broad spectrum of teacher competencies and readiness to implement digital media in 21st-century education. Data analysis yielded several key themes, including:

3.1 Diverse Digital Literacy

Digital literacy levels among teachers varied widely. Some teachers demonstrated high proficiency in using digital tools and effectively integrating them into their lessons to enhance student engagement and learning outcomes. However, many teachers needed more confidence and skill in

using these technologies. This highlights a competency gap that needs to be addressed through targeted training and further support.

3.2 Impact of Professional Development Programs

Professional development programs play an important role in improving teacher competencies related to digital media. Teachers who participated in structured training reported increased confidence and skills in using digital tools pedagogically. However, the effectiveness of these programs varied. Some teachers felt that the training provided was too theoretical and not practical. The availability and quality of professional development opportunities also varied across educational settings, resulting in inconsistent results.

3.3 Infrastructure Challenges

Infrastructure challenges significantly hampered teacher readiness to implement digital media in their classrooms. Schools with limited access to reliable internet, up-to-date hardware, and necessary software face significant barriers to effective digital integration. Teachers in under-resourced areas often feel frustrated by these limitations, which hinder their ability to leverage digital media fully.

3.4 Institutional Support

Institutional support has been shown to be critical in creating an environment that supports digital integration. Schools and institutions prioritizing digital literacy and providing ongoing support to teachers demonstrate higher levels of success in implementing digital media in the classroom. Supportive leadership, access to digital resources, and a collaborative culture among staff contribute to increased teacher readiness and competency.

3.5 Barriers to Implementation

Several barriers to effective digital media implementation were also identified, such as resistance to change, time constraints, and lack of personalized training. Some teachers are reluctant to adopt new technologies due to unfamiliarity or skepticism about their educational value. Time constraints are also a significant challenge as teachers struggle to balance their workload with the demands of learning and integrating new digital tools. Additionally, the lack of personalized training that is tailored to individual needs and teaching contexts limits the effectiveness of professional development efforts.

One of the key findings of this study was the significant gap in digital literacy levels among teachers. While some teachers are comfortable using basic digital tools, many still need help in integrating technology into their teaching. As one interviewee expressed,

> *"I feel confident using basic digital tools, but when it comes to integrating them into my lesson plans, I'm not sure where to start."*

This statement suggests that while teachers understand the general use of technology, challenges arise when they have to apply the technology in more complex teaching contexts. Institutional support also emerged as an important factor in successful digital integration. Several teachers from more technologically advanced schools reported receiving adequate support, such as access to ongoing training and adequate devices. One teacher who participated in a focus group discussion expressed;

> *"Our school provides regular training and appropriate software, so I feel more confident and supported in adopting this technology."*

However, teachers from schools in rural areas often reported limited support, with another participant stating, "*We only get training once, and then we are left to figure it out on our own*." This illustration shows that with ongoing support, digital literacy and the application of technology in teaching become easier, especially in areas with limited infrastructure.

This finding confirms previous research findings that show that varying levels of digital literacy among teachers can affect the effectiveness of technology integration in learning (Matli & Ngoepe, 2020). Some teachers with better technology skills can use digital tools creatively, while less skilled teachers often need help to design effective technology-based teaching strategies. This is in line with

Falloon's (2020) research, which shows that the digital literacy gap between teachers can exacerbate educational inequality.

Furthermore, the findings regarding less applicable professional development programs are in line with research by Sriekaningsih et al. (2019), which highlights the need for more practical training to equip teachers with skills that can be directly applied in the classroom. The differences in outcomes between teachers who receive relevant training and those who do not highlight the importance of designing professional development programs that are tailored to the specific needs of teachers and institutions.

The infrastructure challenges identified in this study are also supported by literature emphasizing the importance of equitable access to technology across all educational settings (Al-Samarraie et al., 2020). With adequate infrastructure, adopting digital technologies becomes easier, especially in rural areas that often lag behind in access to technological resources.

Institutional support emerged as a key element in helping teachers adapt to digital media. These results reinforce the findings of Alhawsawi & Jawhar (2021), which showed that support from educational institutions in the form of leadership, facilities, and a collaborative work culture played a significant role in the successful implementation of technology in schools. Finally, barriers teachers face, such as resistance to change and time constraints, have also been discussed in previous literature. However, these findings provide new insights into the need for more personalized training to address teachers' fears and insecurities in using technology.

This exploratory review highlights the complexity of integrating digital media into 21st-century education. While significant progress has been made, substantial challenges remain. Addressing these challenges requires a multifaceted approach, including enhancing digital literacy, providing effective professional development, investing in infrastructure, and fostering strong institutional support. By addressing these areas, educational systems can better prepare teachers to leverage digital media, ultimately improving student educational outcomes.

Table 1. Recent Developments in Teacher Competency and Readiness in Applying Digital Media

No	Aspect	Recent Developments	Implications
1	Digital Literacy Levels	Increased emphasis on digital literacy in teacher training programs, with new certifications and courses becoming more prevalent.	There is a higher baseline of digital literacy among new teachers, but ongoing professional development is still needed for current teachers.
2	Professional Development	The emergence of blended professional development programs combining online and in-person training, with focusing on practical applications and continuous support.	More effective skill-building and sustained improvement in digital media application among teachers.
3	Infrastructural Challenges	Expansion of government and private sector initiatives to provide schools with better internet access and up-to-date technology, especially in underserved areas.	Improved access to necessary digital tools, enabling more equitable integration of digital media in classrooms.
4	Institutional Support	Growing recognition of the importance of digital leadership, with more schools appointing digital coordinators and technology integration specialists.	Enhanced guidance and support for teachers, leading to more successful and widespread adoption of digital media.

5	Implementation Barriers	Increased focus on addressing time management issues and providing change management support to help teachers integrate digital tools more seamlessly into their routines.	Reduction in resistance to change and more effective time management strategies, facilitating better digital media integration.
6	Best Practices	Adoption of adaptive learning technologies and personalized learning plans, allowing for more tailored educational experiences and better use of digital media.	More personalized and effective teaching strategies, enhancing student engagement and learning outcomes through digital media.
7	Policy and Investment	Significant policy shifts towards prioritizing digital education, with increased funding and support for teacher training and technology integration initiatives.	More consistent and widespread support for digital media integration ensures all teachers have the necessary resources.

This table outlines the latest trends and advancements in the field, highlighting how recent developments address previous challenges and improve teacher competency and readiness in applying digital media. Table 1 shows significant developments in teacher competency and readiness to implement digital media in education. One of the latest developments in professional development is the implementation of blended learning programs, which combine online and face-to-face training. These programs focus on practical applications and offer ongoing support for teachers. Our research results show that this approach has resulted in more sustainable competency improvements among teachers, especially in digital media use skills in the classroom. However, these improvements have not been evenly distributed. As shown in Table 1, infrastructure challenges remain a major obstacle, especially in under-resourced schools.

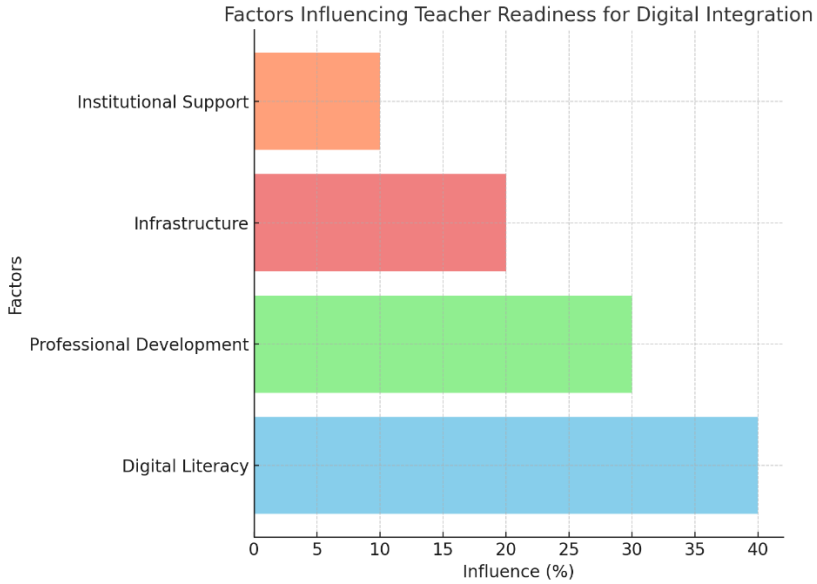

Figure 1. Diagram of factors influencing teacher readiness for digital integration.

Above is a diagram illustrating the key factors influencing teacher readiness for digital integration. The chart visually emphasizes the relative impact of factors such as digital literacy, professional development, infrastructure, and institutional support. This representation provides a clear understanding of how each factor contributes to preparing teachers for the effective incorporation of digital media in education.

Discussion

The findings of this study align with and build upon previous research, such as the work of O'Connor et al. (2023), which highlighted that while some teachers are proficient in using digital tools, many still struggle with both skills and confidence. This study extends those findings by showing that even teachers with high digital literacy face significant challenges in effectively integrating technology into their teaching practices. It suggests that digital competence alone is insufficient; a more holistic pedagogical approach is required to help teachers design meaningful, technology-enhanced lessons.

One key insight from this study is the importance of professional development programs, which are critical to enhancing teacher competency in digital media. While earlier studies, such as Philipsen et al. (2019), and Philipsen et al. (2019), emphasized the need for practical, hands-on training, this study underscores that educators require not only theoretical knowledge but also opportunities to apply this knowledge in real classroom settings. It further highlights the need for a standardized approach to professional development to ensure that training programs deliver consistent, effective outcomes (Baker & Galanti, 2017).

Infrastructural barriers continue to pose significant challenges for the integration of digital media into education. This study corroborates findings from Fenanlampir et al. (2019) Fenanlampir et al. (2019), which identified issues in schools with limited access to reliable internet and modern technology. It suggests that substantial investment in infrastructure is critical to enabling teachers to effectively implement digital tools, particularly in under-resourced schools.

Institutional support also plays a central role in ensuring the successful integration of technology in the classroom. This study reinforces the argument put forth by Alhawsawi & Jawhar (2021), that supportive leadership and a collaborative school culture are essential for fostering digital media adoption. In schools with strong institutional backing—such as access to resources and a culture of collaboration—teachers are more likely to feel confident and capable in using digital media. On the other hand, inadequate institutional support contributes to lower levels of teacher readiness and competency, as seen in the findings of (Nursalim et al., 2022).

This study further explores barriers to effective technology integration, such as resistance to change, time constraints, and the lack of personalized training. These barriers are consistent with findings from Pavlou (2020), which identified similar obstacles to the adoption of digital tools in education. The current study highlights the need for change management strategies and time management support to help educators navigate these challenges. Additionally, the demand for personalized training programs suggests that teacher professional development must be more tailored to individual needs and teaching contexts (Agustina et al., 2023). By addressing these areas, educational systems can better prepare teachers to leverage digital media, ultimately improving student educational outcomes (Pratama et al., 2023). Research by (Legi et al., 2023) emphasized that while some teachers are adept at using digital media, many still need to be prepared still need to be prepared. This review corroborates these findings, revealing a persistent gap in digital competency that needs to be addressed through more targeted and comprehensive training programs.

Based on the findings of this study, professional development needs to be structured more specifically and strategically to meet the diverse needs of teachers across educational contexts. Professional development programs should include several key components (Zaim et al., 2020): 1) Ongoing support: In addition to one-off training, programs should offer ongoing support through peer mentoring and collaboration. This could take the form of mentoring sessions between more experienced teachers and those who are still struggling to integrate digital media into their lessons or study groups where teachers can share best practices. 2) Focus on practical applications: Hands-on workshops should focus on real-world uses of digital media in the context of a specific subject area. For example, for math teachers, training could include using interactive software to teach geometric concepts, while for language teachers, training could include using digital platforms to improve students' writing skills. 3) Blended learning models: Training programs should use a blended learning approach, where online and in-person training is delivered. This approach allows teachers to access

training materials whenever needed while also gaining hands-on experience through interactive, in-person sessions. 4) Contextual adaptation: Programs should be designed to be adapted to local needs and available resources. Training should include creative solutions to integrate simple tools or emphasize project-based teaching that does not necessarily require sophisticated technological infrastructure in areas with less access to technology. 5) Evaluation and feedback: Training should be accompanied by ongoing evaluation and feedback processes, where teachers can assess their own progress and receive feedback from coaches or mentors. This will help ensure that the training has a real impact on everyday teaching practice. Thus, effective professional development should emphasize technical skills and relevant pedagogical applications so that teachers can implement technology effectively and sustainably in the classroom.

Infrastructural challenges continue to pose significant barriers to effective digital integration, as highlighted in earlier research by (Judijanto & Asfahani 2022 Naibaho, 2022). The current study reinforces this issue, particularly emphasizing under-resourced schools' struggles. Reliable internet access, modern hardware, and relevant software are crucial for enabling teachers to leverage digital media effectively. Addressing these infrastructural deficiencies through substantial investment is essential for creating an equitable educational environment where all teachers have the resources necessary to succeed. Institutional support plays a pivotal role in facilitating successful digital media integration. It has been argued that supportive leadership and a collaborative school culture are crucial for adopting technology. The current review supports this assertion, demonstrating that schools with strong institutional backing, including leadership prioritizing digital literacy and providing continuous support, see higher levels of teacher competency and readiness (Asfahani et al., 2023). Conversely, more institutional support is needed to address educators' challenges, leading to inconsistent and often ineffective use of digital tools.

Barriers to implementation, such as resistance to change, time constraints, and lack of personalized training, remain significant. Previously highlighted these issues, and the current findings reaffirm their impact on digital media integration (Artipah et al., 2024). Overcoming these barriers requires strategic change management, effective time management support, and personalized training programs that address individual teacher needs and contexts (Priando Purba et al., 2021).

To deepen the thematic analysis, the article could benefit from incorporating concrete examples from interviews or focus group discussions, offering readers a clearer understanding of the specific challenges and solutions faced by teachers. Richer data can be used to highlight the variations in experiences among teachers from urban and rural environments, or between those working in schools with differing levels of technological support. These real-world examples would provide a more nuanced understanding of how digital media integration varies based on context, and they would underscore the diversity of challenges and strategies employed by teachers.

For instance, teachers from urban schools with access to advanced technological infrastructure might share experiences of confidently using interactive tools, digital assessments, and collaborative online platforms to enhance student engagement. They could describe how institutional support, such as access to professional development workshops and reliable technical support, has enabled them to integrate digital media effectively (Rath et al., 2024). These teachers might also provide insights into how they use technology to personalize learning for diverse student needs, offering concrete examples of how digital tools have positively impacted student outcomes.

On the other hand, teachers in rural schools with limited access to technology could share more challenging experiences. These teachers might discuss the frustrations of working with outdated computers or unreliable internet connections, which hinder their ability to fully integrate digital media into their lessons (Torous et al., 2021). For example, one teacher might describe how she was forced to use printed materials and basic multimedia resources to supplement a lesson because the classroom's internet connection failed. Despite these challenges, these teachers might also describe creative solutions, such as using mobile phones as educational tools or leveraging offline resources, to engage students in learning. Additionally, data from interviews or focus groups could illuminate how teachers in different contexts perceive the role of professional development. Teachers in well-resourced schools

may report that training is readily available and that it is mostly theoretical or generalized, with little opportunity for hands-on practice. In contrast, teachers from schools with fewer resources may express a need for training that focuses more on practical, low-cost solutions tailored to their specific teaching environments. This could involve hands-on workshops that focus on simple, inexpensive tools or strategies that don't require advanced technology but still allow teachers to integrate digital media into their teaching effectively.

By including such examples, the study can better illustrate the varied realities of teachers across different contexts and provide a richer, more detailed understanding of the obstacles they face and the innovative approaches they use to overcome them. This approach would offer a deeper, more comprehensive perspective on teacher readiness and competency, showcasing the diversity of experiences and solutions that exist within the broader theme of digital media integration in education.

In summary, this in-depth analysis reveals that while there has been progress in some areas, significant challenges remain in achieving widespread competency and readiness among teachers in applying digital media. Addressing these challenges requires a multifaceted approach, including enhanced digital literacy training, practical professional development, substantial infrastructural investment, and robust institutional support. By building on the insights from previous research and addressing the persistent gaps identified in this study, educational systems can better prepare teachers to integrate digital media, ultimately improving student educational outcomes effectively.

4. CONCLUSION

The research concludes that teacher readiness for digital integration is shaped by key factors, including digital literacy, professional development, infrastructure, and institutional support. The findings reveal significant disparities in digital literacy among teachers, often influenced by their experience levels, with inadequate infrastructure and insufficiently practical professional development posing major barriers. Institutional support, including resource access and fostering a collaborative culture, was found to enhance readiness. These findings underscore the importance of a multifaceted approach to improving teacher preparedness, with implications for policymakers and educational institutions to invest in targeted training and infrastructure upgrades. However, the study is limited by its focus on a single educational context, which may restrict the generalizability of results to broader settings. Future research should explore these dynamics in diverse educational environments and evaluate the effectiveness of hands-on training programs and scalable infrastructural solutions in bridging the digital competency gap across varying contexts.

Acknowledgments: The author would like to thank all writers from various universities and institutions or institutions throughout Indonesia who have contributed independently and have collaborated to research and write this article to completion. We want to thank the publisher of this journal for providing convenience in reviewing and publishing this article.

REFERENCES

Agustina, I., Siregar, L. A., Husain, D. L., Asfahani, A., & Pahmi, P. (2023). Utilization of Digital Technology in Children's Education to Enhance Creative and Interactive Learning. *At-Tarbawi: Jurnal Pendidikan, Sosial Dan Kebudayaan*, *10*(2), 276–283.

Al-Samarraie, H., Shamsuddin, A., & Alzahrani, A. I. (2020). A flipped classroom model in higher education: a review of the evidence across disciplines. *Educational Technology Research and Development*, *68*, 1017–1051.

Alhawsawi, S., & Jawhar, S. S. (2021). Negotiating pedagogical positions in higher education during COVID-19 pandemic: teacher's narratives. *Heliyon*, *7*(6), e07158. https://doi.org/10.1016/j.heliyon.2021.e07158

Almeida, F., & Simoes, J. (2019). The role of serious games, gamification and industry 4.0 tools in the

education 4.0 paradigm. *Contemporary Educational Technology*, *10*(2), 120–136.

Artipah, A., Sain, Z. H., & Asfahani, A. (2024). Early Childhood Education Reform in Pakistan: Challenges, Innovations, and Future Prospects. *Absorbent Mind: Journal of Psychology and Child Development*, *4*(1), 57–64.

Asfahani, A., El-Farra, S. A., & Iqbal, K. (2023). International Benchmarking of Teacher Training Programs: Lessons Learned from Diverse Education Systems. *EDUJAVARE: International Journal of Educational Research*, *1*(2), 141–152.

Baker, C. K., & Galanti, T. M. (2017). Integrating STEM in elementary classrooms using model-eliciting activities: responsive professional development for mathematics coaches and teachers. *International Journal of STEM Education*, *4*(1), 1–15.

Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research and Development*, *68*, 2449–2472.

Fenanlampir, A., Batlolona, J. R., & Imelda, I. (2019). The struggle of Indonesian students in the context of TIMSS and PISA has not ended. *International Journal of Civil Engineering and Technology*, *10*(2), 393–406.

Jamiah, Y., Fatmawati, F., & Purwaningsih, E. (2019). Internalization of Students' Nationalism Sense through Outbound Learning Based on Local Wisdom. *JETL (Journal Of Education, Teaching and Learning)*, *4*(2), 339–344. https://doi.org/10.26737/jetl.v4i2.1642

Judijanto, L., & Asfahani, A. (2022). 21st Century Economic Transformation: The Impact of Artificial Intelligence on Markets and Employment. *Journal of Artificial Intelligence and Development*, *1*(1), 41–48.

Legi, H., Damanik, D., & Giban, Y. (2023). Transforming Education Through Technological Innovation In The Face Of The Era Of Society 5.0. *Educenter: Jurnal Ilmiah Pendidikan*, *2*(2).

Lyman, F. T., Tredway, L., & Purser, M. (2023). Think-Pair-Share and ThinkTrix: Standard Bearers of Student Dialogue. In *Contemporary Global Perspectives on Cooperative Learning: Applications Across Educational Contexts*. https://doi.org/10.4324/9781003268192-12

Matli, W., & Ngoepe, M. (2020). Capitalizing on digital literacy skills for capacity development of people who are not in education, employment or training in South Africa. *African Journal of Science, Technology, Innovation and Development*, *12*(2), 129–139.

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

Naibaho, L. (2022). Exploring digital technology integration in learning innovation. *International Journal of Academic Research and Development*, *7*(6), 17–23.

Nursalim, A., Judijanto, L., & Asfahani, A. (2022). Educational Revolution through the Application of AI in the Digital Era. *Journal of Artificial Intelligence and Development*, *1*(1), 31–40.

O'Connor, J., Ludgate, S., Le, Q.-V., Le, H. T., & Huynh, P. D. P. (2023). Lessons from the pandemic: Teacher educators' use of digital technologies and pedagogies in Vietnam before, during and after the Covid-19 lockdown. *International Journal of Educational Development*, *103*(January), 1–10. https://doi.org/10.1016/j.ijedudev.2023.102942

Pavlou, V. (2020). Art technology integration: digital storytellying as a transformative pedagogy in primary education. *International Journal of Art & Design Education*, *39*(1), 195–210.

Philipsen, B., Tondeur, J., Pareja Roblin, N., Vanslambrouck, S., & Zhu, C. (2019). Improving teacher professional development for online and blended learning: A systematic meta-aggregative review. *Educational Technology Research and Development*, *67*, 1145–1174.

Pratama, D., Nurwani, N., & Nasution, Y. S. J. (2023). The Effect of Understanding of Financial Literacy and Ease of Digital Payment on the Continuity of Msmes in the Digitalization Era. *Indonesian Interdisciplinary Journal of Sharia Economics (IIJSE)*, *6*(2), 618–638.

Priando Purba, B. E., Riris, I. D., & Muchtar, Z. (2021). Development of Website-Based Learning Media Integrated Inquiri Learning Strategies in Learning Thermochemical Matter Chemistry. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, *4*(1). https://doi.org/10.33258/birle.v4i1.1658

Rafiola, R., Setyosari, P., Radjah, C., & Ramli, M. (2020). The effect of learning motivation, self-efficacy, and blended learning on students' achievement in the industrial revolution 4.0. *International Journal of Emerging Technologies in Learning (IJET)*, *15*(8), 71–82.

Ramlah, R., Riana, N., & Abadi, A. P. (2022). Fun Math Learning For Elementary School Students Through Interactive Puzzle Media. *SJME (Supremum Journal of Mathematics Education)*, *6*(1), 25–34. https://doi.org/10.35706/sjme.v6i1.5775

Rath, K. C., Khang, A., & Roy, D. (2024). The Role of Internet of Things (IoT) Technology in Industry 4.0 Economy. In *Advanced IoT Technologies and Applications in the Industry 4.0 Digital Economy* (pp. 1–28). CRC Press.

Sebsibe, A. S., Argaw, A. S., Bedada, T. B., & Mohammed, A. A. (2023). Swaying pedagogy: A new paradigm for mathematics teachers education in Ethiopia. *Social Sciences and Humanities Open*, *8*(1), 1–10. https://doi.org/10.1016/j.ssaho.2023.100630

Sigit Gesang Permana, R., Roni, M., Rahmawati, W., & Fatihatul, A. H. (2022). Building Joyful Learning to Enhance Students Motivation in Studying English. *Attractive : Innovative Education Journal*, *4*(2).

Sriekaningsih, A., Sarmauli, & Yovania Karubaba, H. (2019). *Teacher Personality Competency In Improving the Interest of Learning Education of Christian Religious In Class Study Xi.1 Senior High School 1 Palangka Raya*. https://doi.org/10.2991/iclick-18.2019.86

Torous, J., Bucci, S., Bell, I. H., Kessing, L. V, Faurholt-Jepsen, M., Whelan, P., Carvalho, A. F., Keshavan, M., Linardon, J., & Firth, J. (2021). The growing field of digital psychiatry: current evidence and the future of apps, social media, chatbots, and virtual reality. *World Psychiatry*, *20*(3), 318–335.

Zaim, M., Refnaldi, & Arsyad, S. (2020). Authentic assessment for speaking skills: Problem and solution for english secondary school teachers in Indonesia. *International Journal of Instruction*, *13*(3). https://doi.org/10.29333/iji.2020.13340a