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A Systematic Literature Review on the Role of Digital Learning Media in Improving Learning Outcomes

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Abstract: This literature study critically examines the evolution and utilization of multimedia learning media in modern education, emphasizing the increasing demands for innovative teaching methods that integrate digital technology. As educational paradigms shift towards learner-centered approaches, teachers are required to leverage digital-based learning media to enhance students' understanding and improve learning outcomes. This study synthesizes findings from twenty recent peer-reviewed articles, providing a comprehensive overview of how digital learning media facilitate effective knowledge delivery and engagement. Unlike traditional tools, digital media offer dynamic, interactive, and accessible learning experiences that align with current technological advancements and educational needs. The analysis reveals key trends, benefits, and challenges in adopting multimedia learning media, highlighting significant opportunities for further development and implementation in diverse learning contexts. This study contributes to the field by consolidating up-to-date evidence on the impact of digital learning media, thereby informing educators, researchers, and policymakers on best practices and future directions in technology-enhanced learning.

Keywords: Multimedia; Learning Media; Digital Learning; Technology Integration; Learning Outcomes; Educational Innovation; Digital-Based Media; Interactive Learning; Technology-Enhanced Learning.

1. Introduction

The integration of technology into education has become increasingly essential in the digital era, where the demands of 21st-century skills—such as critical thinking, collaboration, creativity, and digital literacy—are at the forefront of educational transformation [1], [2]. Learning media function not only as tools for content delivery but also as catalysts for creating more meaningful and engaging learning experiences [3], [4]. These media range from conventional print formats to sophisticated digital solutions including videos, animations, simulations, and interactive software [5].

Despite the widespread use of learning media, many existing implementations still rely on static or one-way communication formats, which often fail to address the needs of diverse learners. The rapid advancement of Industry 4.0 technologies—such as mobile computing, artificial intelligence, and augmented reality—has introduced new opportunities for developing interactive and adaptive learning environments [6]. These innovations offer potential for personalized instruction, real-time feedback, and learner autonomy, which are often lacking in traditional educational settings.

A growing body of literature supports the use of digital media in improving learning outcomes and motivation. However, there remains a critical gap in the development of subject-specific learning media that align with both technological capabilities and pedagogical principles. In particular, subjects like Informatics require media that not only present theoretical content but also foster computational thinking, problem-solving, and hands-on skills in programming and data manipulation—skills that are fundamental to digital fluency in the 21st century [7], [8].

Current educational tools in Informatics tend to focus on either static textual content or fragmented online exercises that are not integrated into a cohesive learning framework [9], [10]. Furthermore, much of the media available lacks interactivity and adaptability, making it difficult to accommodate differences in student readiness, learning pace, or prior knowledge [11], [12]. This presents a significant limitation in maximizing learning outcomes, especially in vocational school contexts, where practical competencies and application-based learning are emphasized [13], [14].

To address these challenges, this study proposes the development of a technology-enhanced learning media tailored for the Informatics subject, specifically designed for vocational high school students. The proposed media integrates multimedia components—text, interactive simulations, guided tutorials, and formative assessments—into a unified platform aimed at improving students' conceptual understanding and engagement. This development is grounded in the ADDIE instructional design model to ensure systematic and iterative refinement [15], [16].

The novelty of this research lies in its focus on context-specific, curriculum-aligned interactive learning media that leverage emerging technologies for Informatics education at the vocational level. By responding to the pedagogical needs and cognitive demands of vocational learners, this study contributes to narrowing the gap between available media tools and actual classroom needs. It also highlights how design-driven educational innovations can play a pivotal role in supporting competency-based learning and preparing students for digitally intensive careers.

2. Material and methods

This study employs a qualitative descriptive research design with the Systematic Literature Review (SLR) as the primary method of investigation. The SLR approach is chosen to systematically collect, evaluate, and synthesize existing literature related to the topic under study. This method allows researchers to map the development of knowledge, identify patterns and trends, as well as uncover gaps and opportunities for further research in a structured and replicable manner [17].

The research process began with the formulation of research questions that served as the foundation for the literature exploration. These questions guided the entire review process, focusing on the use and development of technology-based learning media in vocational education, particularly within the Informatics subject domain. Following this, a comprehensive search for relevant literature was conducted using scientific databases such as Scopus, IEEE Xplore, ScienceDirect, and Google Scholar. The search utilized specific keywords and Boolean operators, ensuring the inclusion of peer-reviewed journal articles, conference papers, and credible academic publications.

After gathering a broad set of studies, a selection process was carried out through rigorous screening of titles, abstracts, and full texts. The inclusion criteria consisted of publications in the last ten years, studies written in English or Indonesian, and research focusing on digital learning media, Informatics education, or related areas in vocational learning contexts. Studies with unclear methodologies, duplicate findings, or lacking relevance to the research questions were excluded.

Once the selection was finalized, data extraction was performed by documenting key elements from each study, such as author(s), publication year, research objectives, methods used, learning media developed or analyzed, target users, and main findings. The extracted data were then analyzed thematically to identify recurring concepts, innovative approaches, and existing limitations in current learning media practices.

The final step involved a critical synthesis and interpretation of findings across studies, which enabled the identification of dominant themes, technological trends, and methodological approaches in the development of educational media for Informatics learning. Furthermore, this process helped reveal gaps in the literature, such as the limited availability of interactive and context-specific media for vocational high school students, and the scarcity of studies integrating emerging technologies like AR, gamification, or adaptive systems into the curriculum [18].

Through this SLR, the study aims to provide a comprehensive and evidence-based overview of current research in the field, serving as a foundation for the

development of new, innovative learning media that are both pedagogically sound and technologically aligned with the needs of Industry 4.0. The insights generated are expected to inform researchers, educators, and policymakers in making strategic decisions and fostering the adoption of effective, engaging, and inclusive educational solutions.

3. Results and discussion

3.1 Results

In this study, the researcher collected journal articles from Google Scholar using the keyword digital learning media. The selected articles were limited to those published between 2019 and 2024.

Table 1. Article Review Summary

No	Author(s)	Title	Method	Findings
1	Nurqozin & Putra	Digital Media-Based Learning in Improving the Quality of Islamic Religious Education at SMK Islam Terpadu Tebuireng III, Indragiri Hilir, Riau	Data collection through interviews, observations, and document studies focusing on Islamic studies teachers and students in grades X, XI, and XII	Digital media significantly impacts student achievement in terms of attitude, knowledge, and skills. Integration into religious learning shows positive results in learning outcomes.
2	Ramadhani et al.	The Effect of Digital Comic Media on Improving Short Story Writing Skills	Experimental research using a quantitative approach with a One-Group Pretest-Posttest Design	Digital comics had a significant effect on writing skills. T-test results showed t-count > t-table (3.2 > 1.697), supporting the alternative hypothesis.
3	Fitriyeni	Development of Digital Student Worksheets Based on Riau Malay Ethnoscience in Elementary Science Subjects	Developmental research using the 4-D Model (Define, Design, Develop, Disseminate)	Validation from material experts showed an average score of 4.5 (90%), indicating the materials were highly valid.
4	Rezeki et al.	Development of Math Learning Media Using Wordwall for Phase E Students	Research and Development (R&D) method	The developed media was found to be valid and practical for use in learning activities.
5	Rosmana et al.	Use of Wordwall Media for Evaluating Animal Respiratory	Classroom Action Research (CAR)	Learning becomes more efficient and effective when media

No	Author(s)	Title	Method	Findings
		Organs in Grade V at SDN 3 Nagri Kaler		is well-aligned with student needs, improving performance.
6	Putri & Syafi	Using Quizizz to Improve Motivation and Learning Outcomes at SMK Migas Bumi Melayu Riau	Descriptive method and observation	Students were more interested in learning with Quizizz compared to traditional methods.
7	Mayasari & Dwita	Effective Communication Training via Google Classroom for Teachers at MAN 2 Model	Blended Learning method combining face-to-face and online instruction	89% of students communicated online with peers, and smaller groups with family (56%) and teachers (35%), mainly about school topics.
8	Suarman	The Effectiveness of Wordwall-Based Learning Media in Enhancing Student Activities in Economics	Experimental research	Wordwall media improved learning activity among grade X students in economics at SMA PGRI Pekanbaru.
9	Ainishifa	The Effect of Wordwall-Based Interactive Media on History Learning Outcomes	Quantitative research	N-gain test showed a normalized gain of 60.28%, indicating a moderate effectiveness of the media.
10	Yanti	Development of Wordwall-Based Linear Equation System Problems for Phase E Students	Research and Development (R&D)	Limited trials showed a practicality score of 78.57%, indicating the media was practical.
11	Nurqozin & Putra	Digital Media-Based Learning to Improve Quality of Islamic Education (duplicate of no.1)	Interviews, observations, document study	Digital media had a strong impact on various aspects of learning: student engagement, teacher skills, classroom environment, and academic achievement.
12	Eliut et al.	Effect of Digital Literacy Learning on Social Media Understanding in Civic Education Students	Quantitative research using survey and causal associative analysis	A significant effect was found between digital literacy and social media understanding (F-count 50.238 > F-table 4.007).

No	Author(s)	Title	Method	Findings
				Regression: $\hat{Y}$ = 11.739 + 0.782X.
13	Asmadi	Use of Wordwall Educational Games to Improve Online Learning	Classroom Action Research (CAR)	Wordwall games increased activeness and understanding, especially in the topic of human reproduction. Vocabulary improvement was also noted.
14	Hari et al.	Optimizing Teachers' Skills in Designing Learning Tools Based on TPACK	Online training via Google Meet with nine teachers	Teachers are recommended to innovate using apps like Kinemaster, Toontastic, Powtoon, and to develop digital assessments via HelpTeaching, Quizizz, ClassMarker.
15	Rahmasari et al.	Using YouTube for Project-Based Learning in Chemistry at SMAN Pintar Riau	Descriptive study using online questionnaires	YouTube helped enhance students' creativity in video editing for project-based learning presentations.
16	Juneli et al.	Development of Digital Comic Learning Media for Concept Mastery in Grade V Elementary Students	Quantitative-descriptive approach	Use of digital comics improved students' mastery of concepts significantly.
17	Winda & Dafit	Analysis of Teachers' Difficulties in Using Online Learning Media in Elementary Schools	Qualitative research with descriptive approach	Teachers faced challenges in designing and operating IT-based media, limited infrastructure, and lack of creativity.
18	Efendi et al.	Android-Based Digital Learning Media Development Training for SMAN 1 Rangsang Barat Teachers	Community service project with material strengthening and tutorials	85% of participants were able to develop Android-based digital learning media using InShot.
19	Annisa et al.	Development of Website-Based Math Learning Videos	Research and Development (R&D)	Validity score from experts reached 88.83%, categorized as

No	Author(s)	Title	Method	Findings
		Using Animaker and Plotagon		highly valid for learning use.
20	Priyatni et al.	Development of a Digital Chemistry Book on Acid-Base Titration Using Inquiry Approach	Developmental research	Teacher assessments rated the digital book as very good. Kappa = 0.814; feasibility scores of 86.67% (individual) and 95% (small group).

In conducting a literature review of several relevant journals, the findings reveal significant improvements across various aspects. One notable area is the increase in activeness, where there is evidence indicating that participation and engagement in specific activities have risen substantially, as reported in the reviewed literature. Additionally, there is an improvement in abilities, reflecting growth and development in individuals' skills and knowledge based on the results of previous studies. Creativity has also shown a notable rise, suggesting a strong drive to generate new and innovative ideas in various contexts, as outlined in the analyzed literature.

Overall, this literature review presents an optimistic view of the positive impacts that can be achieved through various enhancement efforts—whether in terms of activeness, abilities, skills, or creativity.

From the twenty reviewed journals, the percentage distribution of each research result is as follows:

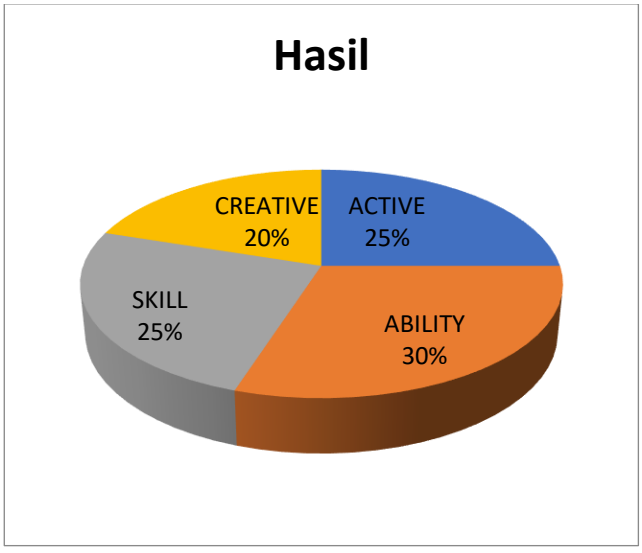

Figure 1. Diagram of Research Results

Based on data extracted from twenty journal articles, the word "Active" appears five times. Activity that reflects activeness is indicative of a high level of engagement or participation in a given environment. This may encompass

actions such as verbal expression, physical movement, or direct interaction with the surrounding context [19].

The term "Ability" is recorded six times within the dataset. Ability is defined as an individual's skill or capacity to perform a task effectively and efficiently within a specific context. This encompasses various domains, including physical, cognitive, and social capabilities necessary to accomplish objectives [20].

The word "Skill" appears five times across the reviewed literature. Skill generally refers to practical or technical competencies that enable individuals to perform specific tasks. These may include tool usage, technological proficiency, effective communication, or analytical reasoning required for task completion [21].

Lastly, the term "Creative" is identified four times within the analyzed sources. Creativity is described as the capacity to produce new ideas, innovative solutions, or original outputs. It involves divergent thinking, the ability to make novel connections, and the exploration of uncharted conceptual spaces, and is widely regarded as a critical attribute in education, innovation, and problem-solving contexts [22]–[24].

3.2 Discussion

The analysis of twenty journal articles published between 2019 and 2024 demonstrates a consistent trend regarding the positive impact of digital learning media on various dimensions of the educational process. The findings reveal four dominant constructs emerging from the data: activeness, ability, skill, and creativity. Each of these constructs plays a critical role in shaping meaningful, student-centered learning experiences in digital environments.

The concept of activeness, mentioned in five studies, reflects the increasing role of digital media in stimulating student engagement. Digital tools such as Wordwall, Quizizz, and interactive comics have been shown to enhance classroom dynamics by promoting active learning behaviors such as participation, verbal interaction, and physical engagement during learning tasks [25]. These findings align with current pedagogical paradigms that emphasize active participation as a key indicator of effective learning. Importantly, such tools are not merely passive content carriers but function as interactive scaffolds that promote real-time feedback and learner autonomy.

The term ability was recorded in six studies, referring to learners' capacities to perform tasks effectively. The reviewed literature provides evidence that the integration of digital media supports not only cognitive development but also broader competencies, including communication, collaboration, and digital literacy [26]–[28]. This is particularly relevant in vocational education contexts

where ability is closely tied to employability and task-based outcomes. The results suggest that digital learning environments enable a more contextualized and skill-oriented learning process that mirrors real-world applications.

Furthermore, the construct of skill, mentioned in five studies, highlights the importance of practical competence in digital education. The reviewed articles report improved student performance in areas such as short story writing, mathematical reasoning, and digital content production, as a result of media-enhanced learning [29]. This suggests that digital media serve as performance amplifiers, enabling learners to apply theoretical knowledge through hands-on practice and iterative feedback. In line with constructivist learning theories, this practical dimension fosters deeper understanding and skill mastery.

The final theme, creativity, emerged in four studies and was often associated with students' ability to generate original ideas and express themselves through digital platforms. Tools like YouTube, Animaker, and digital comics were found to foster creative thinking and self-expression, particularly in project-based learning contexts [30], [31]. These findings are significant, given that creativity is increasingly recognized as a core 21st-century skill. Digital media, by offering multimodal expression and flexible learning pathways, enable students to move beyond rote memorization and toward imaginative problem-solving and innovation.

Collectively, these findings highlight the transformative potential of digital learning media in enhancing the quality of teaching and learning. The review not only confirms previous studies on the benefits of digital tools but also reveals a research gap in the systematic design and integration of these media in vocational school curricula, particularly in subjects like Informatics. While various technologies have been utilized, the lack of holistic instructional design frameworks in their application limits their long-term sustainability and pedagogical effectiveness.

Moreover, while several studies employed validated developmental models (e.g., 4-D or R&D), there remains inconsistency in how outcomes such as creativity and skill are measured. This presents an opportunity for future research to adopt more standardized, multi-dimensional assessment instruments that capture both cognitive and affective learning outcomes in digital contexts.

In conclusion, the reviewed literature strongly supports the role of digital learning media in fostering active engagement, enhancing ability and skill acquisition, and promoting creativity in education. However, the novelty of this review lies in its synthesis of these dimensions into a cohesive framework that can inform evidence-based development of adaptive, context-aware learning media. Future research should prioritize longitudinal studies, cross-platform

integration, and learner analytics to ensure that digital innovations are not only effective but also equitable and inclusive.

4. Conclusion

This study has systematically reviewed twenty journal articles published between 2019 and 2024 to investigate the role and impact of digital learning media in various educational contexts. The findings reveal that digital media contribute significantly to enhancing four key educational constructs: activeness, ability, skill, and creativity. These constructs are consistently supported across diverse methods and learning domains, indicating that digital media are not only effective in improving learning outcomes but also in fostering student engagement and higher-order thinking skills.

The analysis underscores that digital learning media—when properly designed and contextually integrated—can serve as powerful tools to support interactive, learner-centered, and competency-based education. Moreover, the review highlights the positive implications of using tools such as Wordwall, Quizizz, digital comics, YouTube, and other interactive platforms in promoting active participation, practical competency development, and creative expression.

However, despite the promising outcomes, the review also identifies several research gaps that merit further investigation. These include the limited standardization in evaluating media effectiveness across studies, the lack of longitudinal data to assess long-term impact, and the need for media designs that are adaptable to diverse learner profiles and curriculum demands—particularly in vocational and Informatics education.

Therefore, future research should focus on the development and validation of adaptive digital learning media that incorporate personalized learning pathways, real-time analytics, and competency tracking. Additionally, more rigorous experimental and longitudinal studies are needed to evaluate the sustained impact of these media on learning performance, motivation, and skill mastery. Research should also explore cross-platform integration and the application of emerging technologies such as augmented reality (AR), gamification, and artificial intelligence (AI) in media development, ensuring that future innovations are not only pedagogically sound but also scalable, inclusive, and aligned with 21st-century learning goals.

Author's declaration

Author contribution

All aspects of this research were solely conducted by **Fauzan**. This includes the formulation of the research problem, development of the research methodology, collection and analysis of data, synthesis of findings, and the

preparation of the manuscript. **Fauzan** was fully responsible for writing the original draft, revising the content critically, and approving the final version of the manuscript for publication.

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Competing interest

The author declares that there are no competing interests or conflicts of interest related to the publication of this research.

Ethical clearance

This study did not involve any experiments with human participants or animals that require formal ethical approval. All data used were obtained from publicly accessible sources and analyzed in accordance with academic integrity and ethical research standards.

AI statement

Artificial Intelligence (AI) tools, including language models, were utilized solely to support the refinement of academic language, grammar correction, and formatting of the manuscript. All intellectual content, analysis, interpretation of data, and conclusions were solely developed by the author without AI-generated contributions to the core research process.

Publisher's and Journal's note

Universitas Negeri Padang as the publisher and Editor of Jurnal Vokasi Informatika state that there is no conflict of interest towards this article publication.

References

[1] Dr. Lohans Kumar Kalyani, "The Role of Technology in Education: Enhancing Learning Outcomes and 21st Century Skills," *Int. J. Sci. Res. Mod. Sci. Technol.*, vol. 3, no. 4, pp. 05–10, Apr. 2024, https://doi.org/10.59828/ijsrmst.v3i4.199.

[2] N. Churchill, "Development of students' digital literacy skills through digital storytelling with mobile devices," *EMI. Educ. Media Int.*, vol. 57, no. 3, pp. 271–284, 2020, https://doi.org/10.1080/09523987.2020.1833680.

[3] B. Gan, T. Menkhoff, and R. Smith, "Enhancing students' learning process through interactive digital media: New opportunities for collaborative learning," *Comput. Human Behav.*, vol. 51, pp. 652–663, Oct. 2015, https://doi.org/10.1016/j.chb.2014.12.048.

[4] A. Alam and A. Mohanty, "Educational technology: Exploring the convergence of technology and pedagogy through mobility, interactivity, AI, and learning tools," *Cogent Eng.*, vol. 10, no. 2, Dec. 2023, https://doi.org/10.1080/23311916.2023.2283282.

[5] S. Li and J. Li, "Construction of Interactive Virtual Reality Simulation Digital Media System Based on Cross-Media Resources," *Comput. Intell. Neurosci.*, vol. 2022, no. 1, p. 6419128, Jan. 2022, https://doi.org/10.1155/2022/6419128.

[6] J. S. Devagiri, S. Paheding, Q. Niyaz, X. Yang, and S. Smith, "Augmented Reality and Artificial Intelligence in industry: Trends, tools, and future challenges," *Expert Syst. Appl.*, vol. 207, p. 118002, Nov. 2022, https://doi.org/10.1016/j.eswa.2022.118002.

[7] C. B. Omeh, C. J. Olelewe, and E. C. Nwangwu, "Fostering computer programming and digital skills development: An experimental approach," *Comput. Appl. Eng. Educ.*, vol. 32, no. 2, p. e22711, Mar. 2024, https://doi.org/10.1002/cae.22711.

[8] D. S. Papadakis, "Apps to Promote Computational Thinking and Coding Skills to Young Age Children: A Pedagogical Challenge for the 21st Century Learners," *Educ. Process Int. J.*, vol. 11, no. 1, pp. 7–13, 2022, https://doi.org/10.22521/edupij.2022.111.1.

[9] M. Hakimi, S. Katebzadah, and A. W. Fazil, "Comprehensive Insights Into E-Learning in Contemporary Education: Analyzing Trends, Challenges, and Best Practices," *J. Educ. Teach. Learn.*, vol. 6, no. 1, pp. 86–105, Feb. 2024, https://doi.org/10.51178/jetl.v6i1.1720.

[10] J. Alshboul and E. Baksa-Varga, "Ontology-Based Automatic Generation of Learning Materials for Python Programming," *Int. J. Adv. Comput. Sci. Appl.*, vol. 16, no. 5, pp. 71–86, May 2025, https://doi.org/10.14569/IJACSA.2025.0160508.

[11] C. S. Santiago Jr, M. P. Leah Ulanday, Z. R. Jane Centeno, M. D. Cristina Bayla, and J. S. Callanta, "Flexible Learning Adaptabilities in the New Normal: E-Learning Resources, Digital Meeting Platforms, Online

Learning Systems and Learning Engagement," *Asian J. Distance Educ.*, vol. 16, no. 2, p. 38, Dec. 2021, Accessed: Apr. 14, 2025. [Online]. Available: https://asianjde.com/ojs/index.php/AsianJDE/article/view/580.

[12] H. A. El-Sabagh, "Adaptive e-learning environment based on learning styles and its impact on development students' engagement," *Int. J. Educ. Technol. High. Educ.*, vol. 18, no. 1, pp. 1–24, Dec. 2021, https://doi.org/10.1186/s41239-021-00289-4.

[13] E. Kucera and O. Haffner, "Competency-Based Hybrid Learning: A Modern Approach to Teaching Programming and Digital Technologies Subjects," *IEEE Access*, vol. 13, pp. 54892–54919, 2025, https://doi.org/10.1109/access.2025.3555333.

[14] J. Wen and P. Sumettikoon, "Assessing the Impact of Tourism Industry Transformation on Problem-Based Learning in Chinese Vocational Undergraduate Education," *Eurasian J. Educ. Res.*, vol. 2024, no. 110, pp. 183–201, 2024, https://doi.org/10.14689/ejer.2024.110.11.

[15] H. Crompton *et al.*, "Examining technology use within the ADDIE framework to develop professional training," *Eur. J. Train. Dev.*, vol. 48, no. 3–4, pp. 422–454, Mar. 2024, https://doi.org/10.1108/ejtd-12-2022-0137.

[16] L. Mdodana-Zide, "Using ADDIE model for scaffolded learning and teaching intervention," *Interdiscip. J. Educ. Res.*, vol. 6, pp. 1–15, Aug. 2024, https://doi.org/10.38140/ijer-2024.vol6.28.

[17] S. Nazeri, M. Hatala, and C. Neustaedter, "Associations of Research Questions, Analytical Techniques, and Learning Insight in Temporal Educational Research: A Systematic Mapping Study," *J. Learn. Anal.*, vol. 10, no. 2, pp. 68–84, Aug. 2023, https://doi.org/10.18608/jla.2023.7745.

[18] A. D. Samala *et al.*, "Emerging Technologies for Global Education: A Comprehensive Exploration of Trends, Innovations, Challenges, and Future Horizons," *SN Comput. Sci. 2024 58*, vol. 5, no. 8, pp. 1–24, Dec. 2024, https://doi.org/10.1007/S42979-024-03538-1.

[19] M. H. A. Rahman, J. Jaafar, and M. Huda, "Information and Communication Skills for Higher Learners Competence Model," *Lect. Notes Networks Syst.*, vol. 909 LNNS, pp. 357–375, 2024, https://doi.org/10.1007/978-3-031-53549-9_36.

[20] K. Khusnidakhon, "The Importance of Enhancing Social Skills of Preschoolers H," *Eur. Sch. J.*, vol. 2, no. 3, pp. 74–78, 2021, Accessed: Jul. 02, 2025. [Online]. Available: https://www.scholarzest.com.

[21] Muthmainnah, P. M. Ibna Seraj, and I. Oteir, "Playing with AI to Investigate Human-Computer Interaction Technology and Improving Critical Thinking Skills to Pursue 21stCentury Age," *Educ. Res. Int.*, vol. 2022, no. 1, p. 6468995, Jan. 2022, https://doi.org/10.1155/2022/6468995.

[22] A. Valquaresma, "Creativity, Agency and Meaning-Making: Unfolding

Developmental Possibilities in Twenty-First-Century Learning Environments," *Palgrave Stud. Creat. Cult.*, vol. Part F3957, pp. 105–126, 2024, https://doi.org/10.1007/978-3-031-73393-2_5.

[23] T. Chandrasekera, Z. Hosseini, and U. Perera, "Can artificial intelligence support creativity in early design processes?," *Int. J. Archit. Comput.*, Mar. 2024, https://doi.org/10.1177/14780771241254637.

[24] L. Vinet and A. Zhedanov, "A 'missing' family of classical orthogonal polynomials," *J. Phys. A Math. Theor.*, vol. 44, no. 8, pp. 1–14, 2011, https://doi.org/10.1088/1751-8113/44/8/085201.

[25] M. K. Ashari, A. N. Rohmah, U. Yudi, J. Learning, K. Interaktif, and B. Aplikasi, "Joyful Learning With App-Based Interactive Quizzes in Senior," *J. CENDEKIA Media Komun. Penelit. dan Pengemb. Pendidik. Islam Vol.*, vol. 15, no. 02, pp. 210–228, Oct. 2023, https://doi.org/10.37850/cendekia.v15i02.528.

[26] G. Wuyckens, N. Landry, and P. Fastrez, "Untangling media literacy, information literacy, and digital literacy: A systematic meta-review of core concepts in media education," *J. Media Lit. Educ.*, vol. 14, no. 1, pp. 168–182, May 2022, https://doi.org/10.23860/jmle-2022-14-1-12.

[27] G. Falloon, "From digital literacy to digital competence: the teacher digital competency (TDC) framework," *Educ. Technol. Res. Dev.*, vol. 68, no. 5, pp. 2449–2472, Oct. 2020, https://doi.org/10.1007/S11423-020-09767-4.

[28] V. I. Marín and L. Castañeda, "Developing Digital Literacy for Teaching and Learning," *Handb. Open, Distance Digit. Educ.*, pp. 1–20, 2022, https://doi.org/10.1007/978-981-19-0351-9_64-1.

[29] S. Azimkhan, G. Abildinova, A. Khamzina, A. Karymsakova, and C. Karaca, "Developing Teacher Digital Competence through Mobile and Interactive Technologies: A Systematic Review Using the TPACK Framework," *Int. J. Eng. Pedagog.*, vol. 15, no. 3, pp. 33–59, May 2025, https://doi.org/10.3991/ijep.v15i3.51653.

[30] Y. Tong and C. Xie, "Beyond bonding icons: Memes in interactional sequences in digital communities of practice," *Multimodal Commun.*, vol. 14, no. 2, pp. 237–256, Jun. 2025, https://doi.org/10.1515/mc-2024-0116.

[31] J. Jeon;, "Direction for Designing a 3D Animation Curriculum Utilizing AI Technology," *J. Inf. Technol. Appl. Manag.*, vol. 30, no. 5, pp. 141–158, 2023, https://doi.org/10.21219/jitam.2023.30.5.141.