priviet lab.
RESEARCH & PUBLISHING

Priviet Social Sciences Journal

Volume 6 Article 61
Issue 1 January, 2026

28-01-2026

Perceptions of pre-service elementary teachers toward the use of Artificial Intelligence (AI) in science portfolio creation

Edward Harefa

To cite this article: Harefa, E. (2026). Perceptions of pre-service elementary teachers toward the use of Artificial Intelligence (AI) in science portfolio creation. *Priviet Social Sciences Journal, 6*(1), 691-701. https://doi.org/10.55942/pssj.v6i1.1422

To link to this article: https://doi.org/10.55942/pssj.v6i1.1422

Private Social Sciences Journal
E-ISSN 2798-866X
P-ISSN 2798-6314
https://doi.org/10.55942/pssj.v6i1.1422

Volume 6
Issue 1
January Edition 2026

Perceptions of pre-service elementary teachers toward the use of Artificial Intelligence (AI) in science portfolio creation

Edward Harefa

Department of Elementary Education, Universitas Nias, Gunungsitoli 22812, Indonesia
e-mail: edwardharefa@unias.ac.id

Received 10 December 2025
Revised 31 December 2025
Accepted 28 January 2026

ABSTRACT

The increasing availability of Artificial Intelligence (AI) tools has begun to influence teaching, learning, and assessment practices in elementary education, including portfolio-based assessment in science learning. This study explores pre-service elementary teachers' perceptions toward the use of AI in science portfolio creation. Employing a descriptive qualitative research design, data were collected from 15 pre-service elementary teachers through semi-structured interviews and written reflections. The data were analyzed thematically to identify shared perceptions, perceived benefits, and perceived challenges related to AI integration in portfolio-based assessments. The findings revealed that the participants generally held cautiously positive perceptions of AI. They view AI as a supportive tool that can assist students in organizing ideas, improving the clarity of scientific explanations, enhancing visual presentation, and increasing efficiency in portfolio development. However, participants also expressed significant concerns regarding overreliance on AI, reduced critical thinking, authenticity of student work, ethical issues related to authorship and academic honesty, and data privacy. In addition, many participants reported limited preparation and confidence in using AI for instructional and assessment purposes. This study highlights the importance of teacher guidance and clear boundaries to ensure that AI functions as a learning aid rather than as a substitute for student thinking. These findings suggest the need for stronger integration of AI literacy, ethical awareness, and assessment design within teacher education programmes to support the responsible and pedagogically sound use of AI in elementary science education.

Keywords: Artificial intelligence; perception; science learning; portfolio; pre-service teacher

1. INTRODUCTION

The rapid advancement of digital technologies has significantly transformed many aspects of contemporary society, including education. Among these developments, Artificial Intelligence (AI) has emerged as one of the most influential innovations shaping teaching and learning processes (Chen et al., 2020; Philippakos & Rocconi, 2025). AI refers to computer systems designed to perform tasks that typically require human intelligence, such as reasoning, pattern recognition, data analysis, and content generation. In educational contexts, AI has been increasingly applied to instructional design, assessment, personalized learning, and content creation. As schools move toward technology-integrated learning environments, it is essential to examine how future teachers perceive and respond to these emerging tools.

Science education at the elementary level plays a critical role in developing students curiosity, critical thinking, and understanding of the natural world (Harefa & Gulo, 2024). Effective science instruction encourages inquiry, reflection, and knowledge integration through meaningful learning activities. One instructional strategy that supports these goals is portfolio use. Science portfolios allow students to document their learning progress through artifacts such as experimental reports, reflections, diagrams, and project outputs (Doğan et al., 2024; Setyawarno et al., 2025). Portfolios emphasize process-oriented learning and provide opportunities for formative assessment, self-evaluation, and metacognitive development. In recent years, digital portfolios have gained prominence because of their flexibility, accessibility, and capacity to incorporate multimedia elements. The integration of AI into portfolio creation represents a new dimension in science education. AI tools can support students and teachers by generating ideas, organizing content, offering feedback, assisting with data visualization, and enhancing the overall quality of the portfolio artifacts. For example, AI-powered writing assistants can help structure scientific explanations, whereas image generation tools can support visual representations of scientific concepts. These capabilities suggest that AI has the potential to enrich science portfolio creation and improve learning outcomes when used appropriately (Harefa, 2025; Hudori et al., 2020; Sarwandi et al., 2022).

However, the successful integration of AI in educational practice depends largely on teachers readiness, beliefs, and perceptions. Pre-service elementary teachers, as future educators, play a crucial role in determining whether and how AI will be adopted in the classroom. Their perceptions of AI influence their willingness to use these tools, instructional decision-making, and ability to guide students in ethical and effective technology use. Understanding pre-service teachers perceptions is particularly important because they are currently in the process of forming professional identities, pedagogical beliefs, and technological competencies (Sun et al., 2025). Despite the growing presence of AI in education, many pre-service teachers have limited experience with AI applications beyond general consumer technology. This lack of familiarity may lead to uncertainty, skepticism, or misconceptions regarding the role of AI in teaching and learning. Some pre-service teachers may view AI as a supportive instructional tool that enhances creativity and efficiency, whereas others may perceive it as a threat to authentic learning, critical thinking, or academic integrity. Concerns related to overreliance on technology, loss of human agency, data privacy, and ethical implications may also shape their perceptions (Ishmuradova et al., 2025).

These perceptions are particularly relevant in the context of science portfolio creation. Portfolios are intended to reflect students' understanding, inquiry processes, and learning growth. The use of AI in portfolio creation raises important questions regarding authorship, originality, and assessment validity. Pre-service elementary teachers may struggle to determine appropriate boundaries for AI use, such as distinguishing between AI as a learning aid and as a substitute for student thinking (Chung & Jeong, 2024; Ramnarain et al., 2025). Their perceptions influence how they design portfolio tasks, set guidelines for technology use, and evaluate student work. Therefore, teacher education programs are challenged to prepare pre-service teachers to engage critically and constructively with AI. This preparation includes the development of technological pedagogical knowledge, ethical awareness, and reflective attitudes toward emerging technologies. Examining pre-service elementary teachers perceptions of the use of AI in science portfolio creation can provide valuable insights into their readiness to integrate AI into instructional practice. Such insights can inform curriculum development in teacher education programmes, professional development initiatives, and policy decisions related to educational technology integration. Moreover,

understanding these perceptions is timely and necessary because of the increasing availability of AI tools in educational settings. As AI becomes more accessible and user-friendly, its presence in classrooms is likely to expand. Without adequate guidance and positive yet critical perceptions among teachers, the potential benefits of AI may not be fully realized, or its use may lead to unintended negative consequences. Research focusing on pre-service teachers perceptions can help identify the perceived benefits, challenges, and support needs related to AI use in science education (Akanzire et al., 2025).

Although research on AI in education has expanded in recent years, existing studies have largely concentrated on higher education contexts, intelligent tutoring systems, and general AI instructional applications. However, there remains a limited body of research focusing on pre-service elementary teachers, particularly regarding their perceptions of AI use in assessment-oriented practices such as science portfolio creation. Moreover, prior studies rarely address the specific benefits and challenges of integrating AI into portfolio-based assessment, which emphasizes authenticity, reflection, and student agency. Consequently, there is insufficient empirical evidence on how future elementary teachers perceive the pedagogical and ethical implications of using AI in science portfolio creation. Addressing this gap is essential for informing teacher education programs and supporting the responsible and effective integration of AI in elementary science education. This study seeks to explore how pre-service elementary teachers perceive the use of AI in science portfolio creation. Specifically, it aims to understand their overall perceptions toward integrating AI into the development of science portfolios, including how they view its role in supporting learning and assessment. The study also investigates the benefits that pre-service elementary teachers associate with the use of AI in science portfolio creation, particularly in relation to creativity, efficiency, and learning support. In addition, the study examines the challenges and concerns perceived by pre-service elementary teachers, including ethical, pedagogical, and practical issues related to the use of AI in science portfolio based assessment.

2. METHOD

This study employed a descriptive qualitative research design (Creswell, 2022) to explore pre-service elementary teachers perceptions toward the use of AI in science portfolio creation, such as ChatGPT and Gemini. A qualitative approach was considered appropriate because it allows for an in depth understanding of participants experiences, beliefs, and interpretations regarding a complex and emerging phenomenon. By focusing on participants narratives and meanings, the study sought to capture nuanced insights into how pre-service elementary teachers perceive the benefits, challenges, and implications of integrating AI into science portfolio based assessment.

The participants of the study consisted of 15 pre-service elementary teachers enrolled in a teacher education program at Universitas Nias. Participants were selected using purposive sampling to ensure that they had foundational knowledge of science education and exposure to digital tools relevant to portfolio creation. Participants were included in the study if they met the following conditions, such as enrolled as pre-service elementary teachers in a recognized teacher education program, had completed or were currently completing science-related courses requiring portfolio creation, had experience using or were introduced to AI tools, and willing to participate voluntarily and provide informed consent. Data were collected through semi structured interviews and reflective written responses. The semi structured interview format allowed the researcher to guide the discussion using predetermined questions while also providing flexibility for participants to elaborate on their experiences and viewpoints. Interview questions focused on participants understanding of AI, their perceptions of its use in science portfolio creation, perceived benefits, and concerns related to ethical and pedagogical issues. Reflective written responses were used to complement interview data by encouraging participants to articulate their thoughts after engaging with AI supported portfolio tasks or demonstrations.

The data collection process was conducted over four sessions to allow sufficient time for reflection and depth of responses. All interviews were audio recorded with participants permission and later transcribed verbatim to ensure accuracy. Field notes were also maintained to capture contextual information and non verbal cues that could support data interpretation. The combination of interviews,

written reflections, and field notes contributed to data triangulation and enhanced the credibility of the findings. The collected data were analyzed using thematic analysis (Braun & Clarke, 2006; Nowell et al., 2017). Interview transcripts were carefully read and coded to identify recurring patterns and themes. The analysis followed systematic steps, including data familiarization, initial coding, theme development, theme review, and theme definition. This process enabled the researcher to interpret participants' perceptions comprehensively. Initial codes were generated to identify meaningful segments related to participants perceptions, benefits, challenges, and concerns regarding AI use in science portfolio creation. These codes were then grouped into broader categories and refined into emerging themes that represented shared patterns across participants narratives. Throughout the analysis process, reflexivity was maintained to minimize researcher bias and ensure that interpretations remained grounded in participants perspectives.

To ensure the trustworthiness of the study, several strategies were employed. Credibility was enhanced through member checking, where participants were given the opportunity to review and confirm the accuracy of interview transcripts and preliminary interpretations. Dependability was addressed by maintaining a clear audit trail documenting research procedures, coding decisions, and analytical steps. Transferability was supported by providing rich and detailed descriptions of the research context and participants, allowing readers to determine the applicability of the findings to other settings. Confirmability was strengthened through reflective journaling and peer debriefing to ensure that findings were shaped by the data rather than researcher assumptions.

This study was conducted in accordance with established ethical standards for educational research involving human participants. Prior to data collection, ethical considerations were reviewed and approved by the research ethics committee of the author's institution (or deemed exempt from full review according to institutional guidelines for minimal-risk research). All participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without penalty.

3. RESULT AND DISCUSSION

The qualitative analysis of interview transcripts and reflective responses revealed three interconnected themes that represent pre-service elementary teachers perceptions toward the use of AI in science portfolio creation. These themes include perceived pedagogical benefits of AI, perceived challenges and concerns, and perceptions of the evolving roles of teachers and students in AI supported portfolio development. Participants responses indicate a cautiously positive stance toward AI, accompanied by critical reflection on its limitations and ethical implications.

The first theme centers on the perceived pedagogical benefits of AI in science portfolio creation. Most participants described AI as a supportive tool that could assist students in organizing ideas, improving the clarity of explanations, and enhancing the visual presentation of science portfolios. One participant explained that AI could help students who struggle with writing by providing structure and guidance, stating *"Artificial intelligence can help students arrange their ideas better, especially when they do not know how to start explaining an experiment."* Another participant perceived AI as a means of enhancing creativity, noting that *"It gives suggestions for layouts and visuals that make science portfolios more interesting and engaging."* Several participants highlighted the efficiency of AI tools, particularly in reducing time spent on formatting and editing. A participant remarked that *"Using artificial intelligence saves time so students can focus more on understanding the science instead of worrying about grammar or design."* In addition, participants valued the immediate feedback provided by AI tools, which they believed could support revision and learning improvement. One participant shared that *"The feedback from artificial intelligence helps students correct mistakes quickly and improve their explanations before submitting their portfolios."* These responses reflect a perception that AI can function as a learning scaffold that supports students cognitive and creative processes when used appropriately.

The second theme addresses the challenges and concerns associated with the use of AI in science portfolio creation. Despite acknowledging its benefits, participants frequently expressed concerns about students becoming overly dependent on AI. One participant cautioned that *"If students rely too much on artificial intelligence, they might stop thinking deeply and just accept whatever is generated."* Another participant worried

that portfolios created with significant AI assistance might not reflect authentic learning, stating *"It becomes difficult to know whether the portfolio really shows what the student understands."* Ethical concerns were also strongly emphasized. Participants expressed uncertainty regarding authorship and academic honesty, particularly in assessment contexts. One participant noted *"I am not sure how to assess a portfolio fairly if artificial intelligence is used because I cannot tell which part is the student's own work."* Data privacy emerged as another concern, especially when considering elementary students. A participant expressed discomfort by stating *"I worry about students personal information when they use artificial intelligence tools online."* In addition, participants acknowledged their own limited preparation and confidence in using AI for educational purposes. Several participants admitted that their understanding of AI was largely self taught. One participant reflected *"We are expected to use technology, but we are not really trained on how to use artificial intelligence in teaching."* This lack of formal training contributed to hesitation and uncertainty about integrating AI into science portfolio based assessment.

The third theme reflects participants perceptions of the changing roles of teachers and students in AI supported portfolio creation. Participants consistently emphasized that AI should not replace teacher guidance or student thinking. One participant stated *"Artificial intelligence should only assist, not do the work for students."* Another participant highlighted the teacher's responsibility in guiding ethical use, explaining that *"Teachers need to set clear rules so students know how to use artificial intelligence properly."* Participants also stressed the importance of maintaining inquiry based and reflective learning in science portfolios. They believed that AI should support documentation and refinement rather than idea generation or scientific reasoning. One participant remarked *"Students should still do experiments and reflections on their own, while artificial intelligence only helps them organize their portfolio."* Furthermore, participants expressed the need for AI literacy in teacher education programs. A participant suggested *"We need more training so future teachers can confidently and responsibly use artificial intelligence in the classroom."*

This study found that pre-service elementary teachers held cautiously positive perceptions toward using AI in science portfolio creation, while consistently emphasizing the need for ethical boundaries, teacher guidance, and assessment authenticity. When discussed alongside recent journal literature from the past five years, these findings align with a growing pattern in teacher education research that shows acceptance of AI as a supportive tool paired with strong concerns about overreliance and academic integrity. Participants in this study commonly described AI as beneficial for supporting idea organization, improving clarity of scientific explanations, and enhancing portfolio presentation. Similar benefit oriented perceptions have been reported in recent studies of pre-service teachers and teacher education students using generative AI. For instance, Yang & Appleget (2024) research on elementary preservice teachers perceptions of generative AI found that many participants valued such tools for helping with drafting, planning, and improving written outputs, especially when they lacked confidence or needed a starting structure. Kalenda et al. (2025) focused on preservice education students using ChatGPT for lesson planning likewise reported that participants recognized usefulness in generating initial lesson plan drafts and supporting productivity, though they still judged that human review and pedagogical expertise were necessary. Taken together, these studies support the interpretation that pre-service teachers often view AI as a scaffold that can reduce time spent on surface level tasks such as formatting, language editing, and initial drafting, thereby freeing attention for content and reflection, which is consistent with the perceived benefits identified in this research. In alignment with constructivist learning theory (Bada, 2015; Zajda, 2021), the findings suggest that pre-service teachers conceptualize AI as a cognitive scaffold rather than a replacement for learning or professional judgment. Participants' emphasis on AI supporting initial drafting, organization, and clarification of ideas indicates that AI functioned as a tool that enabled learners to actively construct understanding through reflection and refinement.

At the same time, participants in this study repeatedly expressed concerns that AI could reduce students critical thinking and undermine authenticity in portfolio assessment. This mirrors the tension described in recent teacher education and classroom focused research, where educators perceive value in AI but remain wary of learners outsourcing thinking. Empirical work by Gamlem et al. (2025) examined pre-service teachers attitudes and experiences with AI similarly reports mixed perceptions in which usefulness coexists with anxiety about dependency, shallow learning, and misuse. In the present study, this

tension was especially pronounced because portfolios are designed to represent students inquiry processes, reflections, and growth over time. The findings suggest that pre-service teachers interpret portfolio tasks as evidence of learning ownership, and they therefore perceive AI as potentially disruptive when it shifts authorship away from the learner. This aligns with research by Martin et al. (2025) with emerging assessment scholarship indicating that AI complicates validity and fairness in evaluation, particularly when educators cannot easily determine how much of the submitted work reflects the student rather than the tool. From the perspective of constructivist learning theory (Bada, 2015; Zajda, 2021), the concerns expressed by participants regarding AI reducing critical thinking and undermining assessment authenticity are theoretically significant. Constructivism posits that learning occurs through active cognitive engagement, reflection, and personal meaning-making rather than the passive reception of information. In this study, participants' apprehension that AI could encourage students to outsource thinking directly conflicts with constructivist assumptions that learners must actively construct knowledge through inquiry and reflection.

Concerns about AI were particularly pronounced in the context of portfolio-based assessment because portfolios are designed to represent students' learning processes, inquiry trajectories, and reflective thinking over time, rather than only final outcomes. Unlike traditional assignments or tests, portfolios function as evidence of learning ownership and cognitive development. As a result, the introduction of AI tools into portfolio creation heightens concerns about authorship, authenticity, and assessment validity, as it becomes more difficult to determine the extent to which portfolio artifacts reflect students' independent reasoning versus AI-generated support. Participants' apprehension therefore appears to stem not from opposition to technology itself, but from a perceived misalignment between unrestricted AI use and the pedagogical purpose of portfolios as process-oriented, inquiry-driven assessments. This finding suggests that assessment format plays a critical role in shaping teachers' acceptance of AI, with portfolios amplifying ethical and cognitive concerns more strongly than other instructional contexts. This study contributes to prior research on AI in education by demonstrating that portfolio-based assessment, particularly in elementary science contexts, intensifies concerns about authenticity and critical thinking, revealing how assessment purpose shapes pre-service teachers' acceptance and boundary-setting of AI use.

A major contribution of this study is that these concerns were expressed specifically within science portfolio creation, where inquiry, experimentation, and explanation are central. Participants did not simply reject AI. Instead, they tended to support bounded use, such as assistance with organizing artifacts, improving language clarity, or suggesting presentation formats, while resisting uses that replace reasoning or reflection. This balanced stance is echoed in research on AI enhanced portfolio or e portfolio assessment, where learners may appreciate feedback and support features but still require clear guidelines to preserve meaningful learning and credible assessment. The broader implication is that portfolio settings heighten awareness of authenticity, because the portfolio is not only a product but also a narrative of learning. For pre-service elementary teachers, the portfolio purpose appears to function as a lens that shapes how acceptable they find different AI uses (Khasawneh et al., 2025; Laksana et al., 2025).

Another prominent finding found by Ma et al. (2025) that participants voiced uncertainty about ethical boundaries and fair assessment when AI is involved, including questions about authorship and academic honesty. This parallels recent research showing that teachers and teacher educators increasingly acknowledge the importance of ethics, yet experience gaps in perceived control, policy clarity, and practical pedagogical strategies for implementation. In the current findings, the lack of clear guidelines and training contributed to hesitation and inconsistency in how participants imagined assessing AI supported portfolios. This supports the argument that ethics is not only a matter of awareness, but also a matter of capacity building through explicit preparation, tools, and shared norms in teacher education. Relatedly, participants highlighted the need for stronger preparation in teacher education programs, noting limited formal training about AI for instructional and assessment use. This aligns with recent evidence by Sanusi et al. (2024) suggesting that pre-service teachers intention to learn and adopt AI is shaped by attitudes, perceived usefulness, and perceived behavioral control, including whether they feel capable and supported in using AI responsibly. Research by Prilop et al. (2025) focusing on teacher educators perceptions also reinforces that what teacher educators choose to model and include in coursework will shape how pre-

service teachers experience and later enact generative AI practices in schools. The present study extends this line of work by showing that perceived preparedness is not only about technical operation of tools, but also about pedagogical design and assessment literacy, particularly in deciding what constitutes acceptable assistance versus unacceptable substitution.

When comparing this study to recent work on e-portfolios in teacher education by Butakor (2024), an important continuity emerges. Studies exploring pre-service teachers perceptions of e portfolios as assessment tools have found that participants value portfolios for reflection and evidence of learning, but also note implementation barriers such as workload, uncertainty about evaluation criteria, and the need for institutional support (Ouyang et al., 2023; Wang et al., 2024). The present findings suggest that adding AI introduces a new layer to these long standing concerns, because it may both reduce workload through automation and increase complexity through ethical ambiguity. This dual effect implies that AI integration may intensify the demand for clear rubrics, transparent criteria, and process oriented assessment that captures learning development, not merely polished final products.

The discussion across recent studies suggests that the pattern observed here is not isolated. Pre-service teachers generally accept AI as useful, but want it positioned as a tool that enhances learning while preserving student agency. The distinctive contribution of this study is its focus on elementary science portfolios, which appear to amplify concerns about authenticity and critical thinking while also highlighting practical opportunities for scaffolding communication and organization. These findings imply that teacher education should move beyond general AI awareness and toward discipline specific preparation that includes science inquiry practices, portfolio pedagogy, ethical reasoning, and assessment design. Such preparation would help pre-service teachers translate their cautiously positive perceptions into responsible classroom practice that protects both learning quality and assessment credibility. The findings of this study relate to the broader social issue of the digital divide and public trust in education systems (Rojas & Chiappe, 2024; Walter, 2024). While pre-service teachers viewed AI as a useful support for learning and portfolio creation, their concerns about overreliance and assessment authenticity highlight risks to fairness and credibility in education. Unequal access to AI tools and guidance may widen existing educational inequalities, disadvantaging learners with limited digital resources. Moreover, unclear boundaries around AI use can undermine trust in assessment outcomes. These findings suggest that ethical governance, equitable access, and clear instructional policies are essential for responsible AI integration in education.

4. CONCLUSION

This study explored pre-service elementary teachers perceptions toward the use of AI in science portfolio creation and revealed a pattern of cautiously positive acceptance accompanied by critical concerns. The findings indicate that pre-service elementary teachers generally recognize the potential of AI as a supportive tool that can enhance organization, clarity, creativity, and efficiency in science portfolio development. Participants viewed AI as particularly beneficial for assisting with idea structuring, language refinement, and portfolio presentation, thereby allowing greater focus on scientific understanding and reflection. However, the study also identified significant concerns related to over reliance on AI, authenticity of student work, ethical considerations, and assessment validity. Participants expressed apprehension that excessive use of AI could diminish students critical thinking, reduce originality, and obscure genuine evidence of learning within science portfolios. Issues of authorship, academic honesty, and data privacy further contributed to uncertainty, especially in the context of assessing elementary students learning outcomes.

Importantly, the findings highlight that pre-service elementary teachers do not reject AI outright but instead advocate for balanced and guided integration. Participants emphasized the essential role of teachers in setting clear boundaries, providing ethical guidance, and ensuring that AI functions as a learning aid rather than a replacement for student thinking. The study also revealed a perceived lack of preparedness among pre-service teachers, underscoring the need for more explicit training in AI literacy, pedagogical application, and assessment practices within teacher education programs. Overall, this study contributes to the growing body of research on AI in education by providing context specific insights into pre-service

elementary teachers perceptions of AI use in science portfolio creation. The findings underscore the importance of aligning technological innovation with pedagogical purpose, ethical responsibility, and assessment integrity in elementary science education.

Based on the findings of this study, several recommendations are proposed for teacher education programs, educational practice, and future research. First, teacher education programs should integrate AI literacy into their curricula, with particular emphasis on pedagogical and ethical dimensions rather than solely technical skills. Pre-service elementary teachers should be provided with structured opportunities to explore AI tools in science education contexts, including guided practice in portfolio based assessment. Coursework should address responsible use, authorship, academic integrity, and data privacy, enabling future teachers to make informed instructional and assessment decisions. Second, clear guidelines and assessment frameworks should be developed to support the ethical integration of AI gence in science portfolio creation. Teacher educators and curriculum designers should establish transparent criteria that define acceptable and unacceptable uses of AI in portfolio tasks. Emphasis should be placed on process oriented assessment, reflection, and evidence of inquiry to ensure that portfolios continue to represent authentic student learning despite the presence of AI tools. Finally, future research is recommended to expand on the findings of this study by exploring AI use in science portfolio creation across different educational levels, cultural contexts, and subject areas.

Ethical approval

Ethical considerations for this study were reviewed in accordance with institutional guidelines for minimal-risk educational research.

Informed Consent Statement

This research did not require informed consent

Authors' Contributions

Not applicable

Disclosure Statement

No potential conflict of interest was reported by the author.

Data Availability Statement

Not applicable

Funding

This research received no external funding.

Notes on Contributors

Edward Harefa
https://orcid.org/0000-0001-8800-6244
Edward Harefa is a lecturer in the Department of Elementary Education at Nias University. He has published various research results in reputable international journals and accredited national journals, and has received various international and national research grants. His research fields are the integration of

STEAM learning and artificial intelligence in elementary schools, learning media, and educational psychology.

REFERENCES

Akanzire, B. N., Nyaaba, M., & Nabang, M. (2025). Generative AI in teacher education: Teacher educators' perception and preparedness. *Journal of Digital Educational Technology*, *5*(1), ep2508. https://doi.org/10.30935/jdet/15887

Bada, S. O. (2015). Constructivism learning theory: A paradigm for teaching and learning. *IOSR Journal of Research & Method in Education*, *5*(6), 2320–7388. https://doi.org/10.9790/7388-05616670

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*, 77–101. https://doi.org/Using thematic analysis in psychology

Butakor, P. K. (2024). Use of e-portfolios as a teaching, learning and assessment tool in higher education: differing opinions among Ghanaian pre-service teachers and nurses. *European Journal of Education and Pedagogy*, *5*(6), 35–45. https://doi.org/10.24018/ejedu.2024.5.6.858

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, *8*, 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

Chung, J. Y., & Jeong, S.-H. (2024). Exploring the perceptions of Chinese pre-service teachers on the integration of generative AI in English language teaching: Benefits, challenges, and educational implications. *Online Journal of Communication and Media Technologies*, *14*(4), e202457. https://doi.org/10.30935/ojcmt/15266

Creswell, J. W. (2022). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th Editio). SAGE Publications, Inc.

Doğan, Y., Yıldırım, N. T., & Batdı, V. (2024). Effectiveness of portfolio assessment in primary education: A multi-complementary research approach. *Evaluation and Program Planning*, *106*, 102461. https://doi.org/10.1016/j.evalprogplan.2024.102461

Gamlem, S. M., McGrane, J., Brandmo, C., Moltudal, S., Sun, S. Z., & Hopfenbeck, T. N. (2025). Exploring pre-service teachers' attitudes and experiences with generative AI: a mixed methods study in Norwegian teacher education. *Educational Psychology*, *1*, 1–25. https://doi.org/10.1080/01443410.2025.2528663

Harefa, E. (2025). Implementasi pendekatan TPACK berbantuan Liveworksheet terhadap motivasi belajar dan berpikir kritis peserta didik dalam pembelajaran sains di sekolah dasar. *Innovative: Journal Of Social Science Research*, *5*, 2015–2025. http://j-innovative.org/index.php/Innovative/article/download/20438/13662

Harefa, E., & Gulo, H. (2024). Three-dimensional science animation implementation and spatial ability for science concept reconstruction: A gender-based education study. *JPI (Jurnal Pendidikan Indonesia)*, *13*(1), 24–34. https://doi.org/10.23887/jpiundiksha.v13i1.68005

Hudori, R. F. ., Tasnim, Z., Fardhani, A. ., & Sari, D. P. (2020). The use of portfolio assessment in english writing classes. *IOP Conference Series: Earth and Environmental Science*, *485*(1), 012093. https://doi.org/10.1088/1755-1315/485/1/012093

Ishmuradova, I. I., Zhdanov, S. P., Kondrashev, S. V., Erokhova, N. S., Grishnova, E. E., & Volosova, N. Y. (2025). Pre-service science teachers' perception on using generative artificial intelligence in science education. *Contemporary Educational Technology*, *17*(3), ep579. https://doi.org/10.30935/cedtech/16207

Kalenda, P. J., Rath, L., Abugasea Heidt, M., & Wright, A. (2025). Pre-service teacher perceptions of ChatGPT for lesson plan generation. *Journal of Educational Technology Systems*, *53*(3), 219–241. https://doi.org/10.1177/00472395241301388

Khasawneh, M. A. S., Aladini, A., Assi, S. A., & Ajanil, B. (2025). Portfolio assessment in AI-enhanced learning environments: a pathway to emotion regulation, mindfulness, and language learning attitudes. *Language Testing in Asia*, *15*(1), 5. https://doi.org/10.1186/s40468-025-00345-0

Laksana, I. P. Y., Virginiya, P. T., Yuliantini, N. N., Saraswati, N. P. R. T. A. K. H., & Sadiyani, N. W.

(2025). Navigating AI-enhanced learning: A case study of e-portfolio assessment with Gemini AI in business English speaking development. *International Conference on Sustainable Green Tourism Applied Science - Social Applied Science 2025*, *2025*, 177–186. https://doi.org/10.2991/978-94-6463-882-0_21

Ma, M., Ng, D. T. K., Liu, Z., Lin, J., & Wong, G. K. W. (2025). Why don't teachers teach AI ethics? Understanding teachers' beliefs and intentions in Chinese AI curriculum implementation through the theory of planned behaviour. *Computers and Education: Artificial Intelligence*, *9*, 100518. https://doi.org/10.1016/j.caeai.2025.100518

Martin, F., Kim, S., Bolliger, D. U., & DeLarm, J. (2025). Assessment types, strategies, and feedback in online higher education courses in the age of artificial intelligence: Perspectives of instructional designers. *TechTrends*, *69*(6), 1330–1346. https://doi.org/10.1007/s11528-025-01115-8

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis. *International Journal of Qualitative Methods*, *16*(1), 1–13. https://doi.org/10.1177/1609406917733847

Ouyang, F., Wu, M., Zheng, L., Zhang, L., & Jiao, P. (2023). Integration of artificial intelligence performance prediction and learning analytics to improve student learning in online engineering course. *International Journal of Educational Technology in Higher Education*, *20*(1), 4. https://doi.org/10.1186/s41239-022-00372-4

Philippakos, Z. A. T., & Rocconi, L. (2025). AI Literacy: Elementary and secondary teachers' use of AI-tools, reported confidence, and professional development needs. *Education Sciences*, *15*(9), 1186. https://doi.org/10.3390/educsci15091186

Prilop, C. N., Mah, D.-K., Jacobsen, L. J., Hansen, R. R., Weber, K. E., & Hoya, F. (2025). Generative AI in teacher education: Educators' perceptions of transformative potentials and the triadic nature of AI literacy explored through AI-enhanced methods. *Computers and Education: Artificial Intelligence*, *9*, 100471. https://doi.org/10.1016/j.caeai.2025.100471

Ramnarain, U., Ogegbo, A. A., Penn, M., Ojetunde, S., & Mdlalose, N. (2025). Pre-service science teachers' intention to use generative artificial intelligence in inquiry-based teaching. *Journal of Science Education and Technology*, *34*(6), 1272–1285. https://doi.org/10.1007/s10956-024-10159-z

Rojas, M. P., & Chiappe, A. (2024). Artificial intelligence and digital ecosystems in education: A review. *Technology, Knowledge and Learning*, *29*(4), 2153–2170. https://doi.org/10.1007/s10758-024-09732-7

Sanusi, I. T., Ayanwale, M. A., & Tolorunleke, A. E. (2024). Investigating pre-service teachers' artificial intelligence perception from the perspective of planned behavior theory. *Computers and Education: Artificial Intelligence*, *6*, 100202. https://doi.org/10.1016/j.caeai.2024.100202

Sarwandi, S., Wibawa, B., & Wibawa, R. (2022). Usage of e-portfolio as an assessment tool in physics learning. *Journal of Physics: Conference Series*, *2165*(1), 012043. https://doi.org/10.1088/1742-6596/2165/1/012043

Setyawarno, D., Rosana, D., & Kuswanto, H. (2025). 'Assessment as learning' in science instruction: a case study of Indonesian science teachers and notion for optimising in teaching and learning process. *Cogent Education*, *12*(1), 1–15. https://doi.org/10.1080/2331186X.2025.2538337

Sun, J., Wu, Q., Ma, Z., Zheng, W., & Hu, Y. (2025). Understanding pre-service teachers' acceptance of generative artificial intelligence: an extended technology acceptance model approach. *Educational Technology Research and Development*, *73*(4), 1975–1997. https://doi.org/10.1007/s11423-025-10495-w

Walter, Y. (2024). Embracing the future of Artificial Intelligence in the classroom: the relevance of AI literacy, prompt engineering, and critical thinking in modern education. *International Journal of Educational Technology in Higher Education*, *21*(1), 15. https://doi.org/10.1186/s41239-024-00448-3

Wang, S., Wang, F., Zhu, Z., Wang, J., Tran, T., & Du, Z. (2024). Artificial intelligence in education: A systematic literature review. *Expert Systems with Applications*, *252*, 124167. https://doi.org/10.1016/j.eswa.2024.124167

Yang, S., & Appleget, C. (2024). An exploration of preservice teachers' perceptions of Generative AI: Applying the technological Acceptance Model. *Journal of Digital Learning in Teacher Education*, *40*(3), 159–172. https://doi.org/10.1080/21532974.2024.2367573

Zajda, J. (2021). Constructivist learning theory and creating effective learning environments. In *Globalisation and Education Reforms. Globalisation, Comparative Education and Policy Research* (pp. 35–50).

https://doi.org/10.1007/978-3-030-71575-5_3