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Local Product-Based Science and Science Learning and Generative AI: A Model for Strengthening Digital Literacy and Empowering MSMEs in Elementary Madrasahs

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ABSTRACT

Science learning in Madrasah Ibtidaiyah is still dominated by textual and memorization approaches, resulting in low student engagement. This study aimed to describe the implementation of science learning based on local product observation through the use of generative artificial intelligence (AI) in creating promotional flyers in Grade V of MI Ma'arif NU 1 Cilongok. The study employed a qualitative descriptive approach involving 19 fifth-grade students. Data were collected through participatory observation, unstructured interviews, student observation reports, and promotional flyer artifacts, and were analyzed using the Miles and Huberman interactive model. The results showed that all students (100%) successfully completed the four learning stages, namely field observation, report writing, AI-assisted flyer creation, and publication through social media. Student engagement increased from 52.6% before implementation to 100% after the learning activities, accompanied by improvements in creativity and digital literacy. The most notable outcome was the establishment of a collaboration between the Kerupuk Lawas MSME and the Bunda Madani MSME, initiated through a promotional flyer created by the students. This study contributes to the development of an integrative IPAS learning model that combines contextual field observation, Project-Based Learning, and generative AI to strengthen digital literacy while fostering collaboration between schools and local communities. However, the findings should be interpreted within the context of this study, as the research involved only one fifth-grade classroom in a single elementary madrasah and was conducted over a relatively short implementation period.

1. INTRODUCTION

Natural and Social Sciences (Ilmu Pengetahuan Alam dan Sosial—IPAS) is an integrative subject in Indonesia's Independent Curriculum that aims to develop students' understanding of natural and social phenomena through contextual and student-centered learning experiences. At the elementary madrasah level, IPAS is expected to promote critical thinking, creativity, collaboration, and environmental awareness by connecting classroom learning with authentic situations. However, classroom practices remain largely teacher-centered and textbook-oriented, limiting students' opportunities to construct knowledge through direct experience. Preliminary observations conducted in Grade V of MI Ma'arif NU 1 Cilongok revealed that 9 of 19 students (47.4%) were passive during classroom activities because learning relied heavily on memorizing concepts from textbooks rather than relating them to their surrounding environment. As a result, students experienced limited opportunities to develop meaningful understanding through real-life contexts (Andreani & Gunansyah, 2023), a pattern consistent with broader findings that elementary students often struggle to translate classroom material into transferable soft skills without authentic, experience-based

learning opportunities (Aygün *et al.*, 2026). Various instructional approaches have been proposed to address these challenges. Project-Based Learning (PjBL) has been shown to improve students' creativity, participation, and learning outcomes through authentic projects (Mubarokah & Chamdani, 2025; Musa & Kamal, 2024). Likewise, integrating local wisdom and cultural context into problem- and project-based designs enables students to understand concepts through familiar cultural and environmental contexts (Fauzi *et al.*, 2024; Taufan *et al.*, 2023; Allolinggi & Tangkearung, 2024; Annajmi *et al.*, 2026). More recently, generative artificial intelligence (AI) has emerged as a promising educational tool for supporting creativity, personalized learning, and digital literacy, provided that its use is guided by meaningful pedagogical design and teacher facilitation (Boulhrir & Hamash, 2025; Kim & Kwon, 2023; Ottenbreit-Leftwich *et al.*, 2023; Ng *et al.*, 2025; Radloff *et al.*, 2025; de Putter-Smits *et al.*, 2025; Lee & Song, 2024).

Although previous studies have demonstrated the benefits of PjBL, local wisdom-based learning, and AI integration, these approaches have generally been investigated separately. Existing PjBL studies have focused primarily on improving creativity and learning outcomes without incorporating generative AI as a productive learning tool (Mubarokah & Chamdani, 2025; Musa & Kamal, 2024). Similarly, AI research in elementary education has mainly examined teachers' readiness and ethical issues rather than students' productive use of AI in authentic learning contexts (Boulhrir & Hamash, 2025; Ottenbreit-Leftwich *et al.*, 2023; Radloff *et al.*, 2025), a gap that echoes concerns raised in higher-education settings about how assessment and pedagogical practice have yet to adapt fully to generative AI (Antwi-boampong *et al.*, 2026). Studies on local wisdom have also emphasized cultural integration without combining field observation, scientific inquiry, and AI-assisted digital product creation within a unified instructional model (Fauzi *et al.*, 2024). Consequently, empirical evidence regarding the integration of these three components in IPAS learning at Islamic elementary schools remains limited. To address this gap, this study proposes an integrative IPAS learning model that combines direct observation of local Micro, Small, and Medium Enterprises (MSMEs), scientific report writing, and AI-assisted promotional flyer creation. The novelty of this study lies in positioning generative AI not merely as a learning support tool but as a medium through which students transform authentic field observations into meaningful digital products. This approach is expected to strengthen students' conceptual understanding, creativity, digital literacy, communication skills, and awareness of local economic potential an increasingly critical competency, as digital literacy has been shown to shape outcomes ranging from underserved MSMEs' market adoption (Juita *et al.*, 2026) and financial market outcomes such as IPO pricing (Bentes, 2026) to consumers' risk perception (Lv & Yang, 2026) and professionals' acceptance of AI tools across sectors (Awad *et al.*, 2026) while fostering collaboration between schools and surrounding communities. Accordingly, this study addresses three research questions: (1) How is local product observation-based IPAS learning implemented in Grade V of MI Ma'arif NU 1 Cilongok? (2) How do students utilize generative AI to design promotional flyers for local products? and (3) How do students respond to the implementation of the proposed learning model? Therefore, the objectives of this study are to examine the implementation of the proposed learning model, analyze students' engagement in AI-assisted learning activities, and evaluate its contribution to developing creativity, digital literacy, and contextual understanding in IPAS learning at the elementary madrasah level.

2. METHODS

2.1 Research Design and Participants

This study employed a qualitative descriptive design to explore the implementation of Natural and Social Sciences (IPAS) learning based on local product observation assisted by generative artificial intelligence (AI). A qualitative descriptive approach was selected because the

study aimed to describe and interpret the learning process, students' experiences, and the outcomes of the instructional activities in their natural setting without testing hypotheses or establishing causal relationships (Sugiyono, 2016). The research was conducted in Grade V of MI Ma'arif NU 1 Cilongok, Banyumas Regency, Indonesia. The school was purposively selected because it is located in an area with numerous Micro, Small, and Medium Enterprises (MSMEs) producing various local products that can be utilized as authentic learning resources. Furthermore, preliminary classroom observations indicated that IPAS learning remained predominantly teacher-centered and textbook-oriented, resulting in limited student participation. The participants consisted of 19 fifth-grade students aged approximately 10–11 years who were enrolled in one intact classroom. The class represented the entire Grade V cohort at the school; therefore, all students participated in the study. The participants had diverse levels of learning participation and digital skills, and most had no prior experience using generative AI for educational purposes. One Grade V classroom teacher, who had experience implementing the Independent Curriculum, also participated as a key informant by providing pedagogical perspectives on the planning, implementation, and evaluation of the learning activities. Before data collection, permission was obtained from the school principal, and informed consent was secured from the students' parents or guardians. Throughout the study, students' identities were kept confidential, and all reported data were anonymized to ensure ethical compliance. Grade V was chosen because students were considered cognitively capable of conducting field observations, preparing written reports, and using AI-assisted digital applications under teacher supervision (Sugiyono, 2016).

2.2 Data Collection and Research Procedures

Data were collected from both primary and secondary sources. Primary data were obtained through participant observations during classroom and field activities, unstructured interviews with students and the classroom teacher, and field documentation. Secondary data consisted of students' observation reports and AI-assisted promotional flyers, which served as learning artifacts representing students' conceptual understanding, creativity, and digital literacy throughout the learning process (Maulyda *et al.*, 2025). The learning activities were implemented through four sequential stages. First, students received observation guidelines prepared by the teacher, including aspects related to the business environment, production processes, product characteristics, conclusions, and recommendations. Second, students conducted direct observations by visiting local MSMEs near their homes with parental assistance. During these visits, students observed production activities, interacted with MSME owners, and collected field data. Third, students organized their findings into structured scientific observation reports using a teacher-prepared reporting format. Finally, students used generative AI under teacher guidance to design promotional flyers highlighting the local products they had observed.

2.3 Data Analysis and Trustworthiness

The collected data were analyzed using the interactive model of Miles and Huberman, comprising three interconnected processes: data reduction, data display, and conclusion drawing and verification (Sugiyono, 2016). During data reduction, observation notes, interview transcripts, students' reports, and promotional flyers were organized and coded according to the research objectives. The reduced data were subsequently presented through descriptive narratives, matrices, and representative excerpts to facilitate interpretation. Finally, conclusions were continuously verified by comparing findings across different data sources throughout the analysis process. To ensure the trustworthiness of the findings, three validation techniques were employed. First, method triangulation was conducted by comparing information obtained from classroom observations, interviews, students' observation reports, and promotional flyer artifacts (Maulyda *et al.*, 2025). Second, member checking was performed by discussing preliminary findings with participating

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students and the classroom teacher to confirm the accuracy of the researcher's interpretations (Sugiyono, 2016). Third, peer debriefing was undertaken through discussions with colleagues experienced in elementary education and educational technology research to evaluate the consistency of data interpretation and minimize researcher bias (Sugiyono, 2016). The combination of these techniques enhanced the credibility and dependability of the research findings.

3. RESULTS AND DISCUSSION

RESULTS

3.1 Implementation of Local Product Observation-Based Science Learning

The implementation of local product observation-based science learning demonstrated a very high level of student participation. All 19 fifth-grade students of MI Ma'arif NU 1 Cilongok (100%) successfully conducted field observations at MSME production sites located around the school. Some students carried out observations in pairs, encouraging collaboration, discussion, and the exchange of ideas throughout the learning process. Parents actively accompanied students during field visits, creating a supportive learning environment while strengthening collaboration among families, schools, and local MSMEs. In addition, MSME owners welcomed the students by providing access to production activities and answering students' questions throughout the observation process.

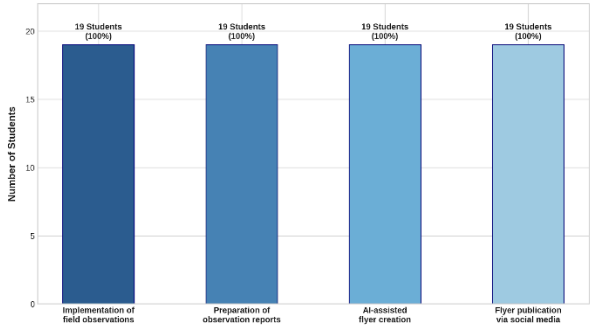

Figure 1. Student Participation Profile in Learning Stages

After completing the field observations, all students prepared observation reports using the reporting format provided by the teacher. The reports documented students' observations of production processes, raw materials, processing techniques, packaging activities, and product distribution. This activity enabled students to organize information systematically while documenting their field experiences. The observation reports also served as the primary source of information for the subsequent learning activities (Shufa, 2018). The final stage of the project involved creating AI-assisted promotional flyers introducing the observed MSME products. Under teacher supervision, all students successfully designed digital promotional materials using AI applications. The resulting flyers presented product information in an attractive visual format and were subsequently disseminated through social media by teachers and students. As presented in Table 1, every stage of the learning process achieved a participation rate of 100% (Abbas *et al.*, 2026; Boulhrir & Hamash, 2025). One observable outcome of this learning project was that the promotional flyer created for the Kerupuk Lawas MSME attracted the attention of another local MSME, Bunda Madani, which later proposed a production collaboration involving tilapia fish bone crackers. This finding indicates that the students' learning products extended beyond classroom activities and generated measurable socio-economic outcomes within the surrounding community.

3.2 Interview Findings

Interview data were collected from students, classroom teachers, and MSME owners to complement the findings obtained during the implementation of the learning activities. Students generally expressed positive experiences after participating in direct field observations. One student

stated, *"I was so happy to be able to see firsthand how crackers are made. I then wrote about it in a report and created a poster using AI. It felt like I was really being a journalist."* This statement illustrates students' enthusiasm toward experiential learning activities (Shufa, 2018; Andreani & Gunansyah, 2023). Teachers also reported noticeable changes in student participation during field-based learning. One classroom teacher explained, *"What I saw was that the children who were usually quiet in class were actually the most enthusiastic during the visit to the MSME. They asked more questions than I expected."* This observation was consistent with the participation data obtained during the implementation of the learning activities (Musa & Kamal, 2024; Mubarokah & Chamdani, 2025). Positive responses were also obtained from the participating MSMEs. The owner of Kerupuk Lawas explained, *"I didn't expect the flyer the children made to be seen by outsiders. Suddenly someone contacted me wanting to buy tilapia bone crackers in large quantities to resell."* This testimony confirms that the learning products generated by students reached audiences beyond the school environment and contributed to expanding business opportunities for local MSMEs (Marini *et al.*, 2025; Wahyuni & Suharini, 2025; Fauzi *et al.*, 2024).

3.3 Challenges During Learning Implementation

Several challenges were encountered during the implementation of the learning activities despite the successful completion of all project stages. The first challenge involved limited access to digital devices, requiring some students to share devices provided by teachers or parents. The second challenge was limited instructional time because the integration of field observation, report writing, AI-assisted flyer creation, and reflection required a longer duration than conventional classroom instruction. The third challenge concerned differences in students' typing abilities, which affected the speed and accuracy of entering prompts into AI applications. These challenges were addressed through device sharing, cross-schedule coordination, parental support, and intensive teacher guidance during learning activities (Ng *et al.*, 2025).

Table 1. Challenges and Solutions in Learning Implementation

No.	Challenge	Impact	Implemented Solutions
1	Limited device access	The flyer making process is hampered	Teachers and parents use devices in turns
2	Limited time allocation	Four stages are difficult to complete in regular hours	Cross-schedule coordination & parent support
3	Variation in students' typing abilities	Obstacles in inputting prompts to AI	Intensive individual teacher mentoring

3.4 Student Engagement Before and After Implementation

One of the most important dimensions of this study is the changes that occurred in students after participating in this learning model. Before implementation, as many as 9 out of 19 students (47.4%) showed inactivity during the learning process, indicating their low engagement and motivation in learning science subjects. After participating in a series of field observations, report writing, and flyer creation activities, the students showed significant changes in attitude; they became more confident in expressing their opinions, more enthusiastic in completing assignments, and better able to connect the subject matter to real life around them. These changes are in line with findings Musa & Kamal (2024)that confirm that when students are involved in authentic, meaningful projects, their intrinsic motivation tends to increase organically without the need for excessive external encouragement. Furthermore, the experience of interacting directly with MSMEs and witnessing the real impact of their work through social media fostered a sense *of ownership* in the learning process, which is an important foundation for the formation of independent learner character as mandated by the Pancasila Student Profile in the Independent Curriculum.

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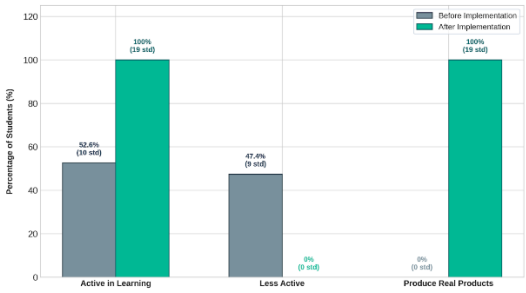

Figure 2. Student Engagement Before and After Implementation

The finding that the use of AI significantly boosted student creativity in this study can be explained through several interrelated mechanisms. First, AI acted as a technological *scaffolding* that lowered technical barriers in the design process; students who previously felt unable to create compelling visual works could now express their creative ideas without being hampered by limited technical skills (Abbas *et al.*, 2026). Second, interacting with AI through prompting *encouraged* students to think more explicitly about what they wanted to convey and how best to convey it, thus indirectly training their critical thinking and communicative skills *(Ng et al.*, 2025). Third, the AI's rapid and visual responses provided instant feedback *that* motivated students to continue experimenting, revising, and refining their work iteratively, a process synonymous with the design thinking cycle *that* is at the heart of 21st-century creativity (Boulhrir & Hamash, 2025). Thus, AI in the context of this study does not function as a substitute for student creativity, but rather as an amplifier that magnifies and expands the creative expression that already exists within each student.

3.5 Comparison with Previous Studies

The findings of this study strengthen and extend the results of previous studies in several significant dimensions. Compared with studies Mubarokah & Chamdani (2025)that implement local wisdom-based PjBL without AI integration, this study shows that the addition of AI components as a creative production tool can produce learning products that not only improve academic competency but also produce tangible artifacts that have a direct impact on the community. Meanwhile, when compared with studies Boulhrir & Hamash (2025)that examine AI in elementary education theoretically, this study provides contextual empirical evidence on how AI can be practically integrated into science and education learning in madrasas with limited resources. Furthermore, unlike studies (Ottenbreit-Leftwich *et al.*, 2023)that emphasize teachers' AI competencies, this study shows that elementary school students can become productive and creative users of AI when provided with a meaningful learning context and structured mentoring. This comparison confirms that the integrative learning model proposed in this study represents a significant advancement in the landscape of technology-based science and education research in Indonesia.

Table 2. Comparison with Previous Studies

Aspect	Mubarokah & Chamdani (2025)	Boulhrir & Hamash (2025)	Ottenbreit-Leftwich *et al.* (2023)	This research
Level	Elementary School/Islamic Elementary School	Basic education	Elementary School	MI Class V
Approach	PjBL + local wisdom	Systematic review of AI	AI literacy teacher	PjBL + local observation + AI
AI Integration	No	Theoretical	Limited	Practical & productive
Student products	Creative work	—	—	Digital promotional flyer
Community impact	Unmeasurable	—	—	MSME cooperation is established

The success of this implementation opens up several concrete and strategic development directions for schools and education stakeholders. First, schools can develop this model into an annual flagship program involving all classes on a rotating basis, so that the economic impact on local MSMEs can be felt more broadly and sustainably. Second, teachers can adapt this learning framework to other subjects such as Indonesian, Mathematics, or Pancasila Education by adjusting the objects of observation and the types of final products produced by students. Third, schools need to build formal partnerships with local MSMEs and the local village government to ensure sustainable field access for students and the availability of adequate technological infrastructure, particularly regarding the availability of devices and a stable internet connection (Marini *et al.*, 2025). Fourth, a written learning module needs to be developed that systematically documents all stages of implementation so that this model can be replicated by other schools in the Islamic elementary school environment throughout Indonesia more easily and standardized. Although this study yields significant findings, several limitations must be honestly acknowledged to maintain scientific integrity. First, the study involved only one class with a relatively small number of subjects, namely 19 students in one madrasah (Islamic school), so the findings cannot be directly generalized to other school contexts or regions with different socio-cultural characteristics and infrastructure. Second, the implementation took place over a limited timeframe, so the long-term impact of this learning model on the development of digital literacy, creativity, and student learning outcomes cannot be comprehensively measured. Third, the significant variation in students' digital abilities is a factor that is difficult to fully control in this study design, potentially affecting the quality of the resulting products between individuals (Heinz *et al.*, 2026). These limitations also serve as recommendations for future researchers to develop similar studies with a broader subject coverage, a longer timeframe, and a research design that allows for longitudinal impact measurement.

DISCUSSION

The findings of this study demonstrate that integrating local product observation with AI-assisted promotional flyer creation provides an authentic and contextual learning experience that supports students' active participation in IPAS learning. By directly observing MSME production activities and transforming their observations into scientific reports and digital promotional materials, students were encouraged to construct knowledge through real-world experiences rather than relying solely on textbook-based instruction. This finding aligns with contextual learning theory, which emphasizes that meaningful learning occurs when students actively connect academic concepts with authentic situations encountered in their daily lives (Shufa, 2018; Andreani & Gunansyah, 2023). However, the present study extends this perspective by demonstrating that authentic experiences alone were insufficient to explain the observed increase in student engagement. The combination of direct observation with AI-assisted product creation enabled students to transform field experiences into tangible digital outputs, making learning more purposeful because their work had an authentic audience beyond the classroom. This suggests that student engagement was influenced not only by contextual learning but also by the opportunity to create products with practical value for the surrounding community. The increased student engagement observed during the implementation may also be explained by the active role that students assumed throughout the learning process. Rather than acting as passive recipients of information, students became investigators who collected field data, interviewed MSME owners, organized their findings, and communicated information through AI-assisted promotional media. These interconnected activities required students to integrate scientific observation, communication, creativity, and digital literacy within a single learning experience. Previous studies have similarly reported that Project-Based Learning enhances participation and creativity by engaging learners in authentic projects (Musa & Kamal, 2024; Mubarokah & Chamdani, 2025).

Nevertheless, unlike previous studies that primarily evaluated academic outcomes or creativity, the present study identified an additional community-oriented outcome, namely the establishment of collaboration between two local MSMEs following the dissemination of a student-produced promotional flyer. Although this finding emerged from a single case and should not be generalized broadly, it indicates that project-based learning integrated with AI has the potential to generate learning outcomes that extend beyond classroom achievement into the local socio-economic context. Another important finding concerns the educational role of generative AI during the learning process. Rather than replacing students' creativity, AI functioned as a cognitive scaffold that reduced technical barriers during promotional flyer design. Students remained responsible for observing local products, selecting relevant information, organizing promotional messages, and evaluating AI-generated outputs before producing their final work. Consequently, AI supported idea generation and visual communication while allowing students to concentrate on higher-order thinking processes such as analysis, evaluation, and creative decision-making. These findings are consistent with previous studies suggesting that AI contributes most effectively to learning when integrated into meaningful pedagogical activities rather than used merely as a technological novelty (Boulhrir & Hamash, 2025; Ng *et al.*, 2025). However, this study differs from much of the existing literature because AI was implemented as a productive learning tool for elementary students instead of being examined primarily from the perspective of teacher readiness or technological competence (Ottenbreit-Leftwich *et al.*, 2023). This finding suggests that, with appropriate teacher guidance and carefully designed learning activities, upper elementary students are capable of using generative AI responsibly to support authentic learning tasks rather than simply consuming AI-generated content.

Compared with previous studies, this research also offers a broader instructional perspective by integrating contextual field observation, scientific report writing, and AI-assisted digital product creation into a single learning framework. Previous studies have generally investigated Project-Based Learning, local wisdom, or artificial intelligence as separate instructional approaches (Mubarokah & Chamdani, 2025; Boulhrir & Hamash, 2025; Ottenbreit-Leftwich *et al.*, 2023). Instead of treating these components independently, the present study demonstrates that their integration creates complementary learning experiences in which contextual inquiry supports scientific understanding, while generative AI facilitates creative communication of students' findings. This integrated design may explain why students not only participated actively but also produced digital artifacts with observable relevance to the local community. Therefore, the contribution of this study lies not merely in confirming the effectiveness of Project-Based Learning or AI integration individually, but in illustrating how these approaches can be combined to strengthen contextual science learning within elementary madrasah education. Despite these contributions, several limitations should be acknowledged. The study involved only one class consisting of 19 students in a single madrasah, limiting the transferability of the findings to other educational contexts. In addition, the relatively short implementation period did not allow the long-term effects of the learning model on students' digital literacy, creativity, and conceptual understanding to be examined comprehensively. Furthermore, the observed socio-economic impact was based on one documented collaboration between local MSMEs. While this provides valuable evidence of the potential community benefits of the learning model, further studies involving multiple schools and a larger number of community partners are needed to determine whether similar outcomes can be consistently achieved in different educational settings. Future studies are therefore encouraged to involve multiple schools, larger participant groups, and longitudinal research designs to evaluate the sustainability and broader applicability of this learning model. Nevertheless, the findings suggest that integrating local product observation, Project-Based Learning, and generative AI provides a promising instructional approach for strengthening contextual learning, digital literacy, creativity, and collaboration between schools and local communities.

4. CONCLUSION

This study demonstrates that integrating local product observation with AI-assisted promotional flyer creation provides an authentic and contextual approach to IPAS learning in elementary madrasahs by promoting students' active participation, creativity, digital literacy, and meaningful understanding of science through real-world experiences. By combining Project-Based Learning, local product observation, and generative AI within a single instructional framework, this study contributes to the growing literature on technology-enhanced and contextual learning while highlighting the potential of school–community collaboration to enrich learning experiences. From a practical perspective, teachers are encouraged to implement this learning model by selecting local MSMEs or community resources that are relevant to students' environments, providing structured guidance for field observations and AI use, and facilitating students in creating meaningful digital products that can be shared with authentic audiences. Schools can further support the implementation of this model by establishing partnerships with local communities, ensuring access to appropriate digital devices and internet connectivity, and providing professional development opportunities that strengthen teachers' competencies in integrating generative AI into contextual learning. Nevertheless, the findings should be interpreted cautiously because the study was conducted in a single classroom with a limited number of participants and within a relatively short implementation period. Therefore, future research is encouraged to examine the applicability and long-term effectiveness of this learning model across different educational settings using larger samples and more comprehensive research designs.

5. REFERENCES

Abbas, Z., Zhang, J., & Junaid, M. (2026). When learning meets the machine: How AI-assisted tools reshape deep and surface learning in higher education. *Computers in Human Behavior Reports*, 22, 101057. https://doi.org/10.1016/j.chbr.2026.101057

Allolinggi, L. R., Tangkearung, S. S., Pasauran, S. A., Alexander, F., & Allo, M. R. (2024). Strategi guru dalam implementasi Proyek Penguatan Profil Pelajar Pancasila (P5) berbasis kearifan lokal di sekolah dasar. *Jurnal Onoma: Pendidikan, Bahasa, dan Sastra*, 10(4), 4596–4605. https://doi.org/10.30605/onoma.v10i4.4448

Andreani, D., & Gunansyah, G. (2023). Persepsi guru sekolah dasar tentang mata pelajaran IPAS pada Kurikulum Merdeka. *JPGSD*, 11(9), 1841–1854. https://ejournal.unesa.ac.id/index.php/jurnal-penelitian-pgsd/article/view/54388

Annajmi, A., Kuswandi, D., Setyosari, P., & Praherdhiono, H. (2026). Integrating multiple representations and local cultural contexts into problem-based learning within a flipped classroom: A new framework for mathematics education. *Social Sciences and Humanities Open*, *13*(February), 102797. https://doi.org/10.1016/j.ssaho.2026.102797

Antwi-boampong, A., Nketia, M. O., Loglo, F. S., Frimpong, N., & Osei-fosuaa, L. (2026). Social Sciences & Humanities Open Rethinking assessment in the age of generative AI : A systematic literature review of African higher education. *Social Sciences & Humanities Open*, *14*(March), 103332. https://doi.org/10.1016/j.ssaho.2026.103332

Awad, W. H. A., Awad, N. H. A., Ashour, H. M. A., Khamis, E. A., Yassen, M. M., Abo baker Ismail, H. I., Mohammed Mohammed syam, N., & Hashem, E. salama. (2026). The Role of Digital Literacy and Ethical Awareness in Nurses' Artificial Intelligence Acceptance: A Cross-sectional Questionnaire Survey. *International Journal of Nursing Studies Advances*, *11*(February), 100577. https://doi.org/10.1016/j.ijnsa.2026.100577

Aygün, H. E., Zeren, Ş. G., Aşıkcan, M., Suskan, T., & Takan, E. N. (2026). Gaining insights into elementary school students' experiences of soft skills at school. *Acta Psychologica*, *267*(February). https://doi.org/10.1016/j.actpsy.2026.107158

Bentes, R. (2026). Too much or too little ? Financial and digital literacy and IPO underpricing in Europe. *Finance Research Letters*, *109*(January). https://doi.org/10.1016/j.frl.2026.110521

Boulhrir, T., & Hamash, M. (2025). Unpacking artificial intelligence in elementary education: A comprehensive thematic analysis systematic review. *Computers and Education: Artificial Intelligence*, 9, 100442. https://doi.org/10.1016/j.caeai.2025.100442

de Putter-Smits, L. G. A., Pols, C. F. J., Dekkers, P. J. J. M., Runhaar, P. R., Timmer, M., & Van der Veen, J. T. (2025). Exploring the role of generative AI in science teacher education programs: a qualitative study. *International Journal of Educational Research Open*, *9*(June), 100492. https://doi.org/10.1016/j.ijedro.2025.100492

Fanani, A., Na'im, M., & Sukidin. (2024). Implementation of Project-Based Learning model in social studies subjects at Islamic junior high school. *International Journal of Contemporary Sciences (IJCS)*, 1(10), 517–534. https://doi.org/10.55927/ijcs.v1i10.10541

Fauzi, W. N. A., & Setiawati, Y. (2024). Integrasi Project-Based Learning (PjBL) dan kearifan lokal dalam pembelajaran IPS di sekolah dasar. *Islamic Elementary School*, 4(2), 1–12.

Heinz, J., Neuberger, F., Eras, L., & Hauck-Thum, U. (2026). Bridging the digital divide? Effects of analog and digital reading interventions in German elementary schools. *Learning and Instruction*, 103, 102324. https://doi.org/10.1016/j.learninstruc.2026.102324

Juita, R., Inan, D. I., & Santoso, B. (2026). Digital market adoption by underserved MSMEs in developing countries: Mediation and moderation by self-efficacy and trust. *International Journal of Information Management Data Insights*, *6*(1). https://doi.org/10.1016/j.jjimei.2025.100384

Kim, K., & Kwon, K. (2023). Exploring the AI competencies of elementary school teachers in South Korea. *Computers and Education: Artificial Intelligence*, 4, 100137. https://doi.org/10.1016/j.caeai.2023.100137

Lee, S., & Song, K. S. (2024). Teachers' and students' perceptions of AI-generated concept explanations: Implications for integrating generative AI in computer science education. *Computers and Education: Artificial Intelligence*, *7*(August), 100283. https://doi.org/10.1016/j.caeai.2024.100283

Lv, J., & Yang, H. (2026). Does digital literacy enhance consumers' perception of food safety risks? *Sustainable Futures*, *12*(February), 101997. https://doi.org/10.1016/j.sftr.2026.101997

Marini, A., Safitri, D., Niladini, A., Zahari, M., Dewiyani, L., & Muawanah, U. (2025). Developing a website integrated with project-based learning: Evidence of stimulating creativity among elementary school students in Indonesia. *Social Sciences & Humanities Open*, 11, 101402. https://doi.org/10.1016/j.ssaho.2025.101402

Maulyda, M. A., Sugiman, Wuryandani, W., Sulistyani, N., & Annizar, A. M. R. (2025). Investigating the role of digital capabilities on the relationship between teacher readiness and teacher skills using augmented reality media in elementary schools: A mediation and moderation analysis. *Social Sciences & Humanities Open*, 11, 101411. https://doi.org/10.1016/j.ssaho.2025.101411

Mubarokah, A., & Chamdani, M. (2025). Penerapan model pembelajaran Project Based Learning (PjBL) dengan kearifan lokal untuk meningkatkan kreativitas dan hasil belajar IPAS kelas IV. *Jurnal Ilmiah Kependidikan (Kalam Cendekia)*, 13(3), 1804–1809. https://doi.org/10.20961/jkc.v13i3.101304

Musa, M. M., & Kamal, R. (2024). Project-based learning model for strengthening elementary students' creativity in sciences. *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, 8(1), 29–42. https://doi.org/10.21831/jk.v8i1.71718

Ng, D. T. K., Chan, E. K. C., & Lo, C. K. (2025). Opportunities, challenges and school strategies for integrating generative AI in education. *Computers and Education: Artificial Intelligence*, 8, 100373. https://doi.org/10.1016/j.caeai.2025.100373

Ottenbreit-Leftwich, A., Glazewski, K., Jeon, M., Jantaraweragul, K., Hmelo-Silver, C. E., Scribner, A., Lee, S., Mott, B., & Lester, J. (2023). Lessons learned for AI education with elementary students and teachers. *International Journal of Artificial Intelligence in Education*, 33(2), 267–289. https://doi.org/10.1007/s40593-022-00304-3

Radloff, J., Yeter, I. H., & Chiu, T. K. F. (2025). Intelligent-TPACK in teacher education: Examining preservice elementary teachers' emerging views about AI classroom use. *Computers and Education Open*, 9, 100307. https://doi.org/10.1016/j.caeo.2025.100307

Shufa, N. K. F. (2018). Pembelajaran berbasis kearifan lokal di sekolah dasar: Sebuah kerangka konseptual. *INOPENDAS: Jurnal Ilmiah Kependidikan*, 1(1), 48–53. https://doi.org/10.24176/jino.v1i1.2316

Suantara, K. A., Gading, I. K., & Sanjaya, D. B. (2023). E-modul berbasis kearifan lokal Satua Bali untuk meningkatkan hasil belajar IPAS siswa sekolah dasar. *Jurnal Ilmiah Pendidikan dan Pembelajaran*, 7(2), 198–206. https://doi.org/10.23887/jipp.v7i2.60241

Sugiyono. (2016). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta.

Taufan, A., Nendissa, J., Sinurat, J., Bormasa, M., Tita, H., Surya, A., Hehanussa, D., Ratri, W., Lewerissa, Y., & Nuraeni, A. (2023). *Kearifan Lokal (Local Wisdom) Indonesia* (Vol. 7, No. 2). Widina Media Utama.

Trisnayanti, N., Lestawi, N., & Sukariawan, M. (2025). Implementasi model pembelajaran Project Based Learning (PjBL) pada mata pelajaran IPAS kelas III di SD No. 1 Petang Badung. *Arzusin: Jurnal Manajemen dan Pendidikan Dasar*, 5(4), 1776–1788. https://doi.org/10.58578/arzusin.v5i4.6290

Wahyuni, S., & Suharini, E. (2025). Pengaruh model pembelajaran berbasis proyek terhadap keterampilan merumuskan solusi inovatif isu SDA lokal pada siswa sekolah dasar. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 10(4), 459–469. https://journal.unpas.ac.id/index.php/pendas/article/view/35589