JIPEI: Journal of Inclusive Primary Education Innovations
E-ISSN:
P-ISSN:
https://ejournal.bbg.ac.id/jipei jipei@bbg.ac.id

IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE (AI)-BASED IPAS BOOKS IN IMPROVING SCIENCE PROCESS SKILLS STUDENT'S

Asmanidar[1] , Lili Kasmini[2], Siti Mayang Sari[3]

[1]*Universitas Bina Bangsa Getsempena, Aceh, Indonesia*
[2]*Universitas Bina Bangsa Getsempena, Aceh, Indonesia*
[3]*Universitas Bina Bangsa Getsempena, Aceh, Indonesia*

Corresponding Author: Asmanidar@email.com

Abstract: The integration of Artificial Intelligence (AI) in education has created new opportunities to enhance students' learning experiences and develop essential scientific competencies. This study aimed to investigate the implementation of an AI-based IPAS (Natural and Social Sciences) book in improving elementary school students' science process skills. The AI-based IPAS book was designed with interactive features, adaptive learning pathways, intelligent feedback, and inquiry-based activities to facilitate scientific exploration and problem-solving. The research employed a quasi-experimental design involving elementary school students as participants. Data were collected through science process skills tests, classroom observations, and student response questionnaires. The implementation of the AI-based IPAS book significantly improved students' science process skills. The average post-test score increased from 63.45 in the pre-test to 84.72 in the post-test, indicating substantial learning gains. Students demonstrated notable improvements in observing, classifying, predicting, experimenting, interpreting data, and communicating scientific findings. Statistical analysis showed a significant difference between pre-test and post-test scores ($p < 0.05$), confirming the effectiveness of the intervention. Questionnaire results indicated that 92% of students responded positively to the AI-based learning experience, reporting increased motivation, engagement, and understanding of scientific concepts. AI-based IPAS book encouraged active participation and inquiry-based learning. Real-time feedback and personalized learning support enabled students to construct scientific knowledge more effectively and independently. The study also demonstrates that AI-supported learning materials can bridge the gap between traditional instruction and the demands of 21st-century education by fostering critical thinking, problem-solving, and scientific literacy.

Keywords: IPAS, Book, AI, Science Process Skills, Elementary School

INTRODUCTION

The rapid advancement of digital technology has transformed educational practices worldwide, creating new opportunities to improve teaching and learning processes. Among these technological innovations, Artificial Intelligence (AI) has emerged as a powerful tool capable of personalizing learning experiences, providing adaptive feedback, and enhancing student engagement (Yang & Taele, 2025). The integration of AI into educational resources has gained significant attention due to its potential to support students' cognitive development and facilitate meaningful learning experiences. In the context of elementary education, AI-based learning materials can help students interact with scientific concepts more actively and

independently (Elfera et al., 2025). AI-based IPAS books are innovative learning media that integrate subject materials with intelligent technology, enabling students to learn actively and independently (Surianto et al., 2025). These books are equipped with interactive features such as automatic exercises, digital illustrations, smart quizzes, and direct feedback that help students understand learning concepts more easily (Elza, 2025).

Science education plays a crucial role in developing students' understanding of natural phenomena and fostering essential skills needed for lifelong learning (Novitasari et al., 2025). In Indonesia, the subject of Ilmu Pengetahuan Alam dan Sosial (IPAS) is designed to integrate scientific and social knowledge while encouraging students to explore, investigate, and solve real-world problems (Bengio et al., 2021). Classroom observations and previous studies indicate that many elementary school students still experience difficulties in mastering science process skills due to teacher-centered instructional approaches, limited learning resources, and insufficient opportunities for inquiry-based activities (Sari, Fidawati, et al., 2025). As a result, students often focus on memorizing concepts rather than developing the skills necessary to conduct scientific investigations (Nurjannah, 2025). Science process skills are fundamental competencies that enable students to acquire knowledge through scientific inquiry (Sofianti, 2025). These skills include observing, classifying, measuring, predicting, formulating hypotheses, experimenting, interpreting data, and communicating findings. The development of science process skills is essential because it not only improves students' understanding of scientific concepts but also enhances critical thinking, problem-solving, and decision-making abilities (Gabriel, 2024). Innovative learning resources are needed to facilitate the acquisition of these skills and create more engaging learning environments (Cheng et al., 2025).

The implementation of AI-based IPAS books offers a promising solution to address these challenges. Unlike conventional textbooks, AI-based books can provide interactive content, adaptive learning pathways, intelligent tutoring features, real-time feedback, and personalized learning experiences (Maulidin, 2024). Through these features, students are encouraged to actively participate in learning activities, explore scientific phenomena, and conduct investigations independently (Nababan et al., 2024). AI technology can support differentiated instruction by accommodating diverse learning needs and providing appropriate learning assistance based on individual student performance (Sahputra et al., 2025). AI-based IPAS books offers a promising solution to address these challenges (Sobar et al., 2024). Unlike conventional textbooks, AI-based books can provide interactive content, adaptive learning pathways, intelligent tutoring features, real-time feedback, and personalized learning experiences (Ningtiyas et al., 2019). Students are encouraged to actively participate in learning activities, explore scientific phenomena, and conduct investigations independently. AI technology can support differentiated instruction by accommodating diverse learning needs and providing appropriate learning assistance based on individual student performance (Purba et al., 2025).

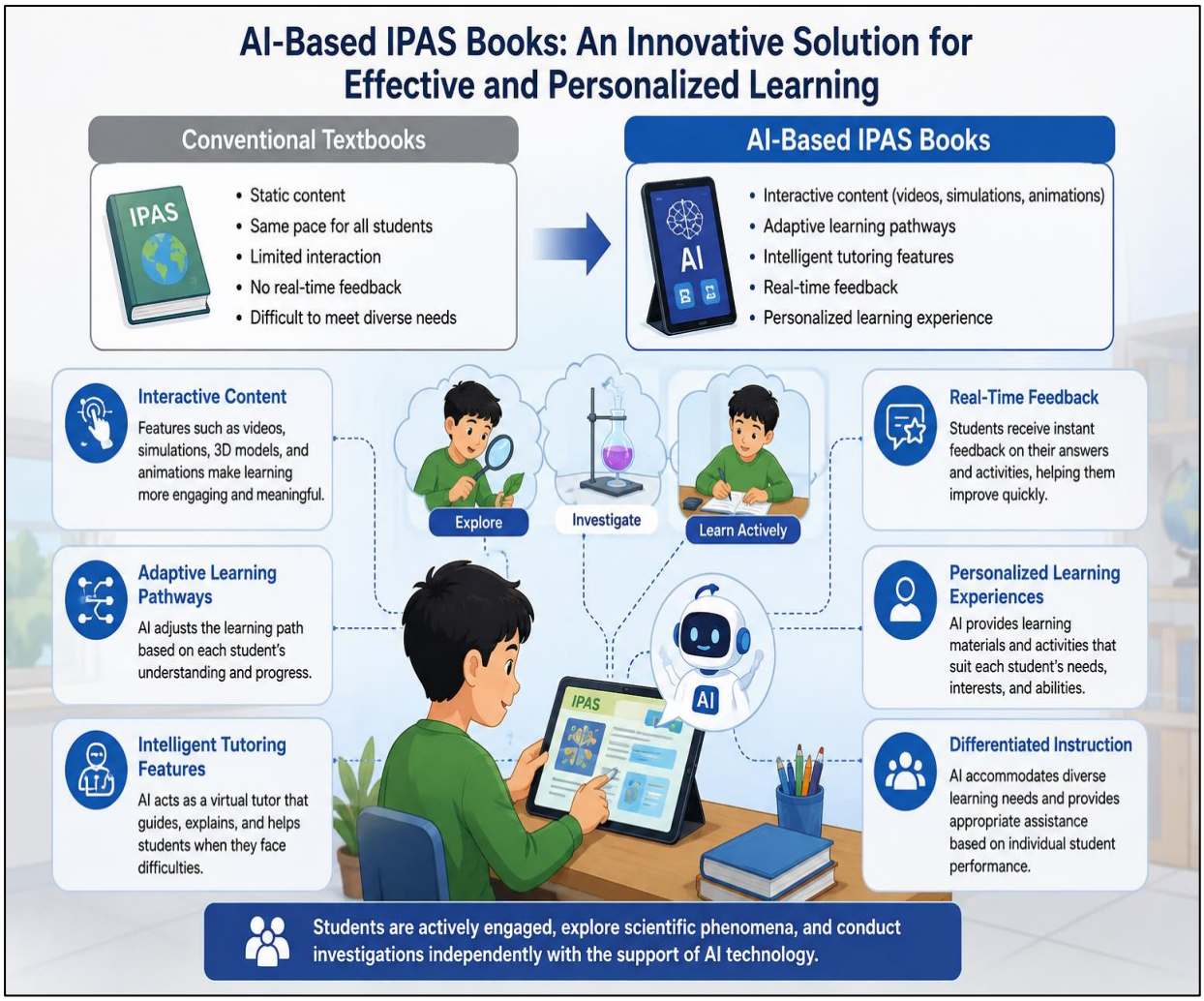

Figure: 1. Efectivinees AI-Based IPAS Books

Artificial Intelligence into science learning materials, students are expected to become more active learners and develop higher levels of science process skills, including observing, classifying, predicting, experimenting, interpreting data, and communicating scientific findings. This ultimately contributes to improved scientific literacy and better preparedness for learning in the digital era. This study aims to investigate the implementation of an AI-based IPAS book in improving students' science process skills. Specifically, the study examines the effectiveness of the AI-based learning resource in enhancing students' abilities to observe, classify, predict, experiment, interpret data, and communicate scientific findings. The findings of this study are expected to contribute to the development of innovative educational technologies and provide practical recommendations for teachers, curriculum developers, and policymakers seeking to improve the quality of science education in the digital era.

METHOD

This study employed a quantitative approach using a quasi-experimental research design with a one-group pretest–posttest model. The design was selected to examine the effectiveness of implementing an Artificial Intelligence (AI)-based IPAS book in improving students' science process skills. Students' science process skills were measured before and after the intervention to determine the learning gains resulting from the use of the AI-based learning material. The participants of this study consisted of 30 fourth-grade students from an elementary school in Indonesia. The participants were selected using purposive sampling based on the school's readiness to implement digital learning resources and the availability of technological facilities. The students had diverse academic backgrounds and learning abilities, representing typical elementary school learners. Participation in this study was voluntary. Permission was obtained from the school administration, classroom teachers, and students' parents before conducting the research. All collected data were treated confidentially and used solely for academic research purposes.

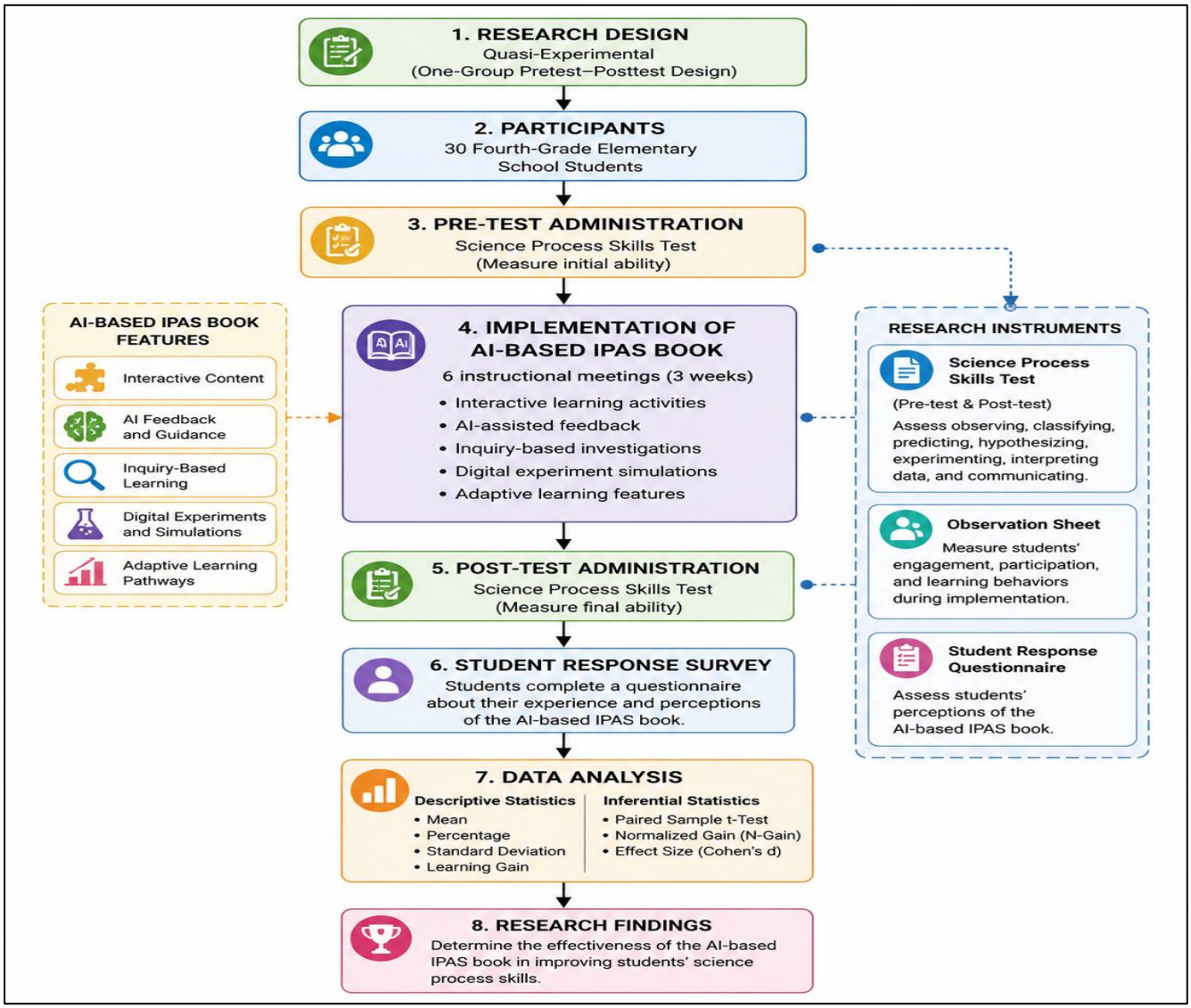

Figure: 2. Research Method Design

RESULT AND DISCUSSION

The effectiveness of the AI-based IPAS book was evaluated by comparing students' science process skills before and after the implementation. The results showed a significant improvement in students' performance following the intervention. The implementation of the AI-based IPAS book was conducted for six instructional sessions over three weeks. To evaluate its effectiveness, students completed a science process skills test before (pre-test) and after (post-test) the intervention.

Table 1. Comparison of Pre-test and Post-test Scores

Test	Mean	SD	N-Gain
Pre-test	63.45	8.72	
Post-test	84.72	6.35	0.58

The results showed a substantial increase in students' science process skills after using the AI-based IPAS book. The mean score increased from 63.45 to 84.72, indicating an improvement of 21.27 points. The average N-Gain score of 0.58 falls within the moderate category, demonstrating that the AI-based IPAS book effectively enhanced students' scientific skills. A paired-sample t-test revealed a statistically significant difference between the pre-test and post-test scores ($p < 0.05$), indicating that the intervention contributed significantly to students' learning outcomes. To identify specific areas of improvement, students' performance was analyzed according to seven science process skill indicators.

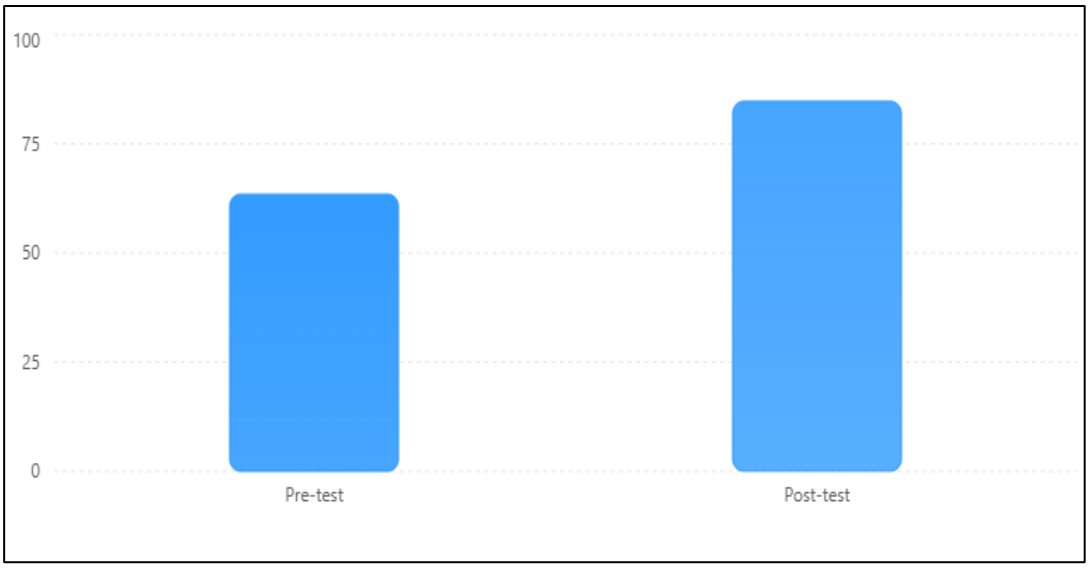

Figure: 3. Pretest and Posttest Graph

The graph shows a substantial increase in students' science process skills after the implementation of the AI-based IPAS book. The mean pre-test score was 63.45**,** while the mean post-test score increased to 84.72, resulting in a gain of 21.27 points. This improvement indicates that the AI-based IPAS book effectively supported students in developing scientific inquiry abilities, including observing, classifying, predicting, hypothesizing, experimenting, interpreting data, and communicating scientific findings. The increase in scores suggests that integrating Artificial Intelligence into learning materials can create a more interactive,

personalized, and engaging learning environment that enhances students' science process skills.

Table 2. Science Process Skill Achievement

Indicator	Pre-test (%)	Post-test (%)	Improvement (%)
Observing	65.20	88.50	23.30
Classifying	62.40	84.30	21.90
Predicting	60.10	82.70	22.60
Hypothesizing	58.30	81.20	22.90
Experimenting	64.50	86.80	22.30
Interpreting Data	61.80	83.60	21.80
Communicating	62.10	85.40	23.30

The highest improvement was found in observing and communicating skills, each increasing by 23.30%. These findings suggest that students became more capable of identifying scientific phenomena and communicating their findings after engaging with the AI-supported learning activities. The overall response rate reached 92.4%, indicating that students highly appreciated the AI-based IPAS book. Most students reported that the interactive features and personalized feedback helped them better understand scientific concepts and complete inquiry-based activities.

The findings demonstrate that the implementation of the AI-based IPAS book significantly improved students' science process skills. The increase in post-test scores indicates that AI-supported learning materials can effectively facilitate scientific inquiry and enhance students' engagement in the learning process. One of the major factors contributing to this improvement is the interactive nature of the AI-based IPAS book. Unlike traditional textbooks that mainly provide static information, the AI-based IPAS book incorporates multimedia resources, simulations, adaptive learning pathways, and intelligent tutoring systems. These features create a dynamic learning environment that encourages students to actively participate in scientific investigations rather than passively receiving information. The significant improvement observed in observing and experimenting skills can be explained by the inquiry-based learning activities embedded within the AI-based IPAS book. Students were required to observe scientific phenomena, conduct virtual experiments, record evidence, and draw conclusions. Such activities align with constructivist learning theory, which suggests that knowledge is actively constructed through meaningful interactions with learning environments. Through direct exploration and investigation, students developed a deeper understanding of scientific concepts and processes.

The AI system provided immediate feedback and adaptive recommendations based on students' performance. This feature allowed students to identify misconceptions quickly and receive targeted assistance, thereby promoting self-regulated learning. As a result, students were able to learn at their own pace while maintaining high levels of motivation and engagement (Sari, Bangsa, et al., 2025). The positive student responses further support the effectiveness of the AI-based IPAS book. More than 90% of students reported that the learning resource was easy to use, interesting, and helpful in understanding scientific concepts (Yaseen et al., 2025). These findings indicate that integrating AI technology into educational materials can increase students' motivation and willingness to participate in learning activities. Previous studies have similarly reported that AI-assisted learning environments contribute to greater student engagement, academic achievement, and higher-order thinking skills (Pendidikan & Hasanah, 2026). AI-based IPAS book also supports the development of 21st-century competencies, including critical thinking, problem-solving, communication,

creativity, and digital literacy (Fitas, 2025). By engaging students in inquiry-oriented activities and providing intelligent learning support, the AI-based book prepares learners to face the challenges of an increasingly technology-driven society (Mahbub, 2024). The research was conducted in a single school with a limited number of participants, which may affect the generalizability of the findings (Smart et al., 2023). Future studies should involve larger samples and experimental control groups to provide stronger evidence regarding the effectiveness of AI-based learning materials. Longitudinal research is also recommended to investigate the long-term impact of AI-supported learning on students' scientific literacy and academic achievement (Mardhatillah et al., 2024). AI-based IPAS book is an effective educational innovation that promotes active learning and significantly improves students' science process skills. The integration of Artificial Intelligence into science learning resources offers promising opportunities for transforming elementary science education and fostering meaningful learning experiences in the digital era.

CONCLUSION

The findings of this study demonstrate that the implementation of an Artificial Intelligence (AI)-based IPAS book effectively improves elementary school students' science process skills. The significant increase in post-test scores compared to pre-test scores indicates that the AI-based learning resource successfully enhanced students' abilities in observing, classifying, predicting, formulating hypotheses, experimenting, interpreting data, and communicating scientific findings. The moderate N-Gain score further confirms the effectiveness of the intervention in supporting meaningful learning outcomes. The positive impact of the AI-based IPAS book can be attributed to its interactive content, adaptive learning pathways, intelligent tutoring features, real-time feedback, and personalized learning experiences. These features encouraged students to actively engage in inquiry-based activities, explore scientific phenomena independently, and develop a deeper understanding of scientific concepts. Moreover, the high level of student satisfaction suggests that AI-supported learning environments can increase motivation, participation, and overall learning engagement. The study also highlights the potential of AI technology to support differentiated instruction by accommodating diverse learning needs and providing individualized learning assistance. As a result, AI-based instructional materials can contribute not only to improved academic achievement but also to the development of essential 21st-century competencies, including critical thinking, problem-solving, communication, and digital literacy. AI-based IPAS book represents an innovative and effective educational tool for enhancing science process skills in elementary education. The integration of Artificial Intelligence into science learning materials offers promising opportunities to transform traditional learning environments into more interactive, personalized, and student-centered experiences. Future research is recommended to involve larger samples, multiple educational settings, and longer implementation periods to further investigate the long-term impact of AI-supported learning on students' scientific literacy and academic performance.

REFERENCE

Bengio, Y., Lecun, Y., & Hinton, G. (2021). Deep learning for AI. *Communications of the ACM*, *64*(7), 58–65. https://doi.org/10.1145/3448250

Cheng, C. C., Wang, J. S., Zhai, X., Ting, Y., & Yang, C. (2025). AI literacy and gender equity in elementary education : A quasi - experimental study of a STEAM – PBL – AIoT course with questionnaire validation. *International Journal of STEM Education*.

Elfera, M., Azril, R., Ali, T., & Sriwahyuni, T. (2025). Personalisasi Pembelajaran Berbasis Ai Untuk Transformasi Menuju Pendidikan Abad 21 Yang Berpusat Kepada Siswa. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *10*.

Elza, P. (2025). Inovasi Pendidikan Inklusi : AI dan Teknologi Bantu untuk Siswa

Berkebutuhan Khusus di Sekolah Dasar. *Jurnal Inovasi Pendidikan*, *1*(1), 29–34.

Fitas, R. (2025). *Inclusive Education with AI: Supporting Special Needs and Tackling Language Barriers*. 1–63. http://arxiv.org/abs/2504.14120

Gabriel, J. (2024). How Artificial Intelligence (AI) impacts inclusive education. *Educational Research and Reviews*, *19*(6), 95–103. https://doi.org/10.5897/err2024.4404

Mahbub, S. (2024). *Gen Z and Generative AI : Shaping the Future of Learning and Creativity*. *4*(10), 1–18. https://doi.org/10.47760/cognizance.2024.v04i10.001

Mardhatillah, Kusumaningrum, S. R., Anggraini, A. E., Faizah, S., Ihsan, M. A. N., & Kasmini, L. (2024). Integration of Project-Based STEM Learning in the Meliuk Menerjang Material within the Emancipated Curriculum. *Jurnal Penelitian Pendidikan IPA*, *10*(SpecialIssue), 31–38. https://doi.org/10.29303/jppipa.v10ispecialissue.7774

Maulidin, S. (2024). Penerapan Pembelajaran Adaptif Berbasis Kecerdasan Buatan(Ai)Untuk Meningkatkan Kinerja Siswa Dengan Kebutuhan Khusus Di Kelas Inklusif. *Teacher : Jurnal Inovasi Karya Ilmiah Guru*, *4*(3), 128–139.

Nababan, K., Siregar, D. M., Anna, W., Kuendo, C., Baluntu, W., Said, A. P., & Gulo, W. (2024). AI-Based Interactive Module : Elementary School Teacher Solution to Reduce Work Stress in the Era of Education 5 . 0. *Jurnal Ilmiah Sekolah Dasar*, *8*(4), 655–663.

Ningtiyas, T. W., Setyosari, P., & Praherdiono, H. (2019). Pengembangan Media Pop-Up Book Untuk Mata Pelajaran Ipa Bab Siklus Air Dan Peristiwa. *Jurnal Kajian Teknologi Pendidikan*, *2*(2), 115–120.

Novitasari, Y., Wahyuni, S., Fadillah, S., Putri, A. A., & Kasriyati, D. (2025). *Advokasi Teknologi : Integrasi Artificial Intelligence (AI) untuk Pembelajaran pada Lembaga PAUD Inklusi Kota Pekanbaru*. *III*(02), 47–55.

Nurjannah[1], Suryani[2], Fitri Mahyuni3, S. M. S. (2025). *Pemanfaatan Aplikasi Canva AI dalam Merancang Pembelajaran di Tingkat SMP untuk Meningkatkan Motivasi Belajar Siswa Utilizing the Canva AI Application in Designing Learning at the Junior High School Level to Increase Student Learning Motivation*. *5*(3), 1726–1734.

Pendidikan, J. T., & Hasanah, F. N. (2026). *The Implementation Of Canva Ai As A Digital Learning Medium In Primary Schools With Limited Resources : A*. *11*(1), 126–132. https://doi.org/10.32832/educate.v11i1.22398

Purba, N., Pujiati, D., Sihombing, P. S. R., Simanjuntak, H., & Sijabat, D. (2025). The Use of AI in Elementary School Learning : A Systematic Literature Review. *QALAMUNA: Jurnal Pendidikan, Sosial, Dan Agama*, *17*(1), 83–98. https://doi.org/10.37680/qalamuna.v17i1.6761

Sahputra, D., Sari, S. M., & Syarfuni. (2025). Utilization of AI In Platform-Based Learning to Improve the. *Journal of Educational Sciences*, *9*(5), 4461–4470.

Sari, S. M., Bangsa, B., & Aceh, B. (2025). *AI-Science Learning with a Deep Learning Approach to Improve Inclusive Student Learning Outcomes*. *12*(4), 1217–1224.

Sari, S. M., Fidawati, Zahraini, & Akmaluddin. (2025). AI-Science Learning with a Deep Learning Approach to Improve Inclusive Student Learning Outcomes. *Jurnal Eduscience (JES)*, *12*(4), 1217–1224.

Smart, L., Environments, L., Ka, C., Chan, Y., & Lee, K. K. W. (2023). The AI generation gap : Are Gen Z students more interested in adopting generative AI such as ChatGPT in teaching and learning than their Gen X and millennial generation teachers ? *Smart Learning Environments*, *3*. https://doi.org/10.1186/s40561-023-00269-3

Sobar, C., Riza, R., & Anggia, S. (2024). AIED (Artificial Intelligence in Education): Opportunities and Challenges in Improving Learning Efficiency in the Era of Society 5 . 0. *PROGRESIVA*, *13*(01), 91–100. https://doi.org/10.22219/progresiva.v13i01.30007

Sofianti, I. D. (2025). *Implementation of Artificial Intelligence (AI) -Based Recruitment Models in the Selection of Lecturers and Educational Staff at the Academy of Hospital Administration Mataram (AARS)*. *7*(2), 1615–1619.

Surianto, D. F., Zulfikar, M. I., Hasnining, A., & Agusnaya, N. (2025). Pemberdayaan Masyarakat Sekolah melalui Penguatan Literasi Digital Berbasis AI dan AR dalam Eksplorasi Sains di SMAN 4 Barru. *Jurnal Pengabdian Masyarakat Dan Riset Pendidikan*, *4*(2), 7186–7196.

Yang, C., & Taele, P. (2025). AI for Accessible Education: Personalized Audio-Based Learning for Blind Students. In *Proceedings of Augmented Educators and AI: Shaping the Future of Human-AI Collaboration in Learning on CHI 2025 Workshop (Augmented Educators and AI(CHI 2025 Workshop))* (Vol. 1, Issue 1). Association for Computing Machinery. http://arxiv.org/abs/2504.17117

Yaseen, H., Mohammad, A. S., Ashal, N., Abusaimeh, H., & Ali, A. (2025). The Impact of Adaptive Learning Technologies , Personalized Feedback , and Interactive AI Tools on Student Engagement : The Moderating Role of Digital Literacy. *MDPI*, 1–27.