Al-Hijr: Journal of Adulearn World, 4(1) – March 2025 36-46

E-ISSN 2829-4351
P-ISSN 2829-3894

The Role of The Teacher as A Facilitator in Project-Based Learning with AI Support

Jung Yuna [1], Kim Minho [2], Han Jiwon [3], Lee Jiwon [4], Suyitno [5]
[1] *Korea University, South Korea*
[2] *Seoul National University, South Korea*
[3] *Hanyang University, South Korea*
[4] *Yonsei University, South Korea*
[5] *Universitas Gresik, Indonesia*

Corresponding Author: Jung Yuna, E-mail; jungyuna@gmail.com

Received: April 3, 2025	Revised: April 23, 2025	Accepted: April 23, 2025	Online: April 23, 2025

ABSTRACT
Project-based learning (PBL) has gained widespread recognition as an effective instructional method that promotes critical thinking, collaboration, and problem-solving skills among students. In this context, the role of the teacher as a facilitator is crucial in guiding students through the learning process while encouraging autonomy and exploration. With the increasing integration of artificial intelligence (AI) in education, AI tools have become valuable resources to support both teachers and students in PBL environments. However, the specific role of teachers as facilitators in AI-supported PBL settings remains underexplored. This study aims to investigate the role of the teacher as a facilitator in project-based learning environments where AI tools are utilized to enhance the learning experience. A mixed-methods approach was employed, including surveys, interviews, and classroom observations involving 150 students and 20 teachers from schools implementing AI-supported PBL. The study assessed the impact of AI tools on teacher facilitation and student outcomes in terms of engagement, creativity, and problem-solving abilities. The results indicate that AI tools significantly supported teachers in managing and facilitating PBL, allowing for more personalized guidance and efficient task management. Students reported higher levels of engagement and improved collaboration, while teachers emphasized the increased ability to focus on individualized support. This study concludes that the teacher's role as a facilitator is essential in leveraging AI tools to optimize project-based learning, enhancing both teaching practices and student outcomes.

Keywords: *Artificial Intelligence, Education Technology, Student Engagement*

Journal Homepage https://ejournal.staialhikmahpariangan.ac.id/Journal/index.php/alhjr/

How to cite: Yuna, J., Minho, K., Jiwon, H., Jiwon, L & Suyitno, Suyitno. (2025). The Role of The Teacher as A Facilitator in Project-Based Learning with AI Support. *Al-Hijr: Journal of Adulearn World*, 4(1), 36-46. https://doi.org/10.55849/alhijr.v4i1.855
Published by: Sekolah Tinggi Agama Islam Al-Hikmah Pariangan Batusangkar

INTRODUCTION

Project-based learning (PBL) has long been recognized as an effective pedagogical approach that fosters student engagement, creativity, and critical thinking. In PBL, students engage in real-world, complex projects that require them to apply their knowledge and skills in collaborative settings (Le dkk., 2025; Shiva Krishna Reddy &

Kathiravan, 2025). The role of the teacher in PBL, traditionally seen as a guide or mentor, is crucial in supporting students as they navigate the learning process. Teachers act as facilitators who provide guidance, encourage reflection, and scaffold learning. However, with the rapid advancement of educational technologies, particularly artificial intelligence (AI), the dynamics of PBL are evolving. AI has the potential to transform the way teachers facilitate learning by offering personalized learning experiences, supporting data-driven decisions, and streamlining administrative tasks. This change raises important questions about the evolving role of teachers in PBL environments that incorporate AI tools and technologies (Ezquerra dkk., 2025; Nguyen dkk., 2025). The integration of AI can potentially enhance the teacher's role as a facilitator by providing more individualized support and enabling greater opportunities for student-centered learning.

Despite the growing interest in AI's application in education, the integration of AI tools into PBL, specifically in how it affects the teacher's role as a facilitator, has received limited attention. Many studies have explored the benefits of PBL for enhancing student engagement and learning outcomes, and other research has examined the potential of AI in education, especially in personalized learning (Balakrishnan & Vidya, 2025; Siegle, 2025). However, little research has specifically addressed how AI can support and redefine the teacher's role in PBL environments. Teachers in AI-supported classrooms may face new challenges in managing technology, integrating it into lessons, and maintaining the balance between guiding students and fostering autonomy. This gap in research is crucial, as understanding how AI tools can augment teacher facilitation in PBL is essential for improving teaching practices and optimizing learning experiences. Therefore, this research focuses on investigating how AI supports the teacher's role as a facilitator in PBL, particularly how it influences student engagement, collaboration, and problem-solving abilities.

The aim of this study is to explore and assess the role of the teacher as a facilitator in AI-supported project-based learning (Abdalla, 2025; Cheung dkk., 2025). The study seeks to evaluate how AI tools enhance the teacher's ability to facilitate student learning, particularly in terms of providing personalized feedback, managing learning resources, and supporting collaborative learning activities. This research also aims to examine how AI integration influences student outcomes, such as creativity, problem-solving skills, and engagement with the learning process. The study will focus on understanding the dynamics between teachers, students, and AI tools, exploring both the benefits and challenges faced by educators in this new learning environment. Additionally, the research will investigate how teachers perceive the changes in their role and how they adapt to using AI technologies as part of their facilitation methods (Revathy dkk., 2025; Vasou dkk., 2025). By addressing these objectives, the study will contribute valuable insights into the practical applications of AI in enhancing the facilitation of PBL, offering guidance for educators and institutions seeking to implement AI-driven learning environments effectively.

A thorough review of existing literature reveals several gaps in research regarding the use of AI in PBL and its influence on teacher facilitation. While research on PBL

emphasizes the importance of the teacher's role in fostering a collaborative and reflective learning environment, there is limited research on how AI tools impact this dynamic. Studies that explore AI in education often focus on personalized learning for students or the technical aspects of AI integration but tend to overlook the teacher's perspective in PBL contexts (Revathy dkk., 2025; Ruano-Borbalan, 2025). Additionally, most literature on AI integration in classrooms focuses on its role in content delivery or assessment, rather than how it can support the facilitation of collaborative, inquiry-based learning. This research seeks to fill these gaps by focusing specifically on how AI tools support and reshape the teacher's role in PBL. By examining the interplay between AI, teachers, and students, this study provides new insights into the potential of AI to enhance teacher facilitation and optimize learning outcomes in project-based learning environments.

This research introduces a novel perspective on the use of AI in PBL by examining its direct impact on the teacher's role as a facilitator. While AI has been explored in terms of its benefits for personalized student learning and data analytics, this study offers a unique contribution by focusing specifically on the teacher's perspective in a project-based context. The novelty lies in addressing how AI tools can enhance the facilitation of student-driven projects, encouraging autonomy, collaboration, and problem-solving (Altikriti & Nemrawi, 2025; Wong dkk., 2025). This study also contributes to the field by offering empirical evidence on the integration of AI in teaching practices, providing a framework for educators to understand how AI can be effectively used to support PBL. The findings will be particularly valuable for institutions seeking to integrate AI into their teaching methods, offering a balanced view of both the opportunities and challenges that arise when AI tools are incorporated into project-based learning. The research highlights the need for ongoing professional development for educators to ensure they are equipped to leverage AI in a way that complements and enhances their role as facilitators of student learning.

RESEARCH METHODOLOGY

This study employs a mixed-methods research design to investigate the role of the teacher as a facilitator in project-based learning (PBL) environments that incorporate artificial intelligence (AI) tools. The research design integrates both quantitative and qualitative data collection methods to provide a comprehensive understanding of how AI supports the facilitation process in PBL (Taeza, 2025; Wong dkk., 2025). The quantitative data will focus on assessing student outcomes such as engagement, collaboration, and problem-solving skills, while qualitative data will capture the perceptions of teachers and students regarding the integration of AI into PBL. This approach allows for a holistic analysis of the teacher's role and how AI can enhance or challenge that role in real-world learning contexts.

The population for this study includes secondary school students and teachers from three schools that have adopted AI-supported PBL in their classrooms. A total of 150 students and 15 teachers will be selected for the study. The sample will consist of students enrolled in PBL-based courses that incorporate AI tools, ensuring a diverse representation

across various subjects and grade levels. Teachers will be chosen based on their active involvement in facilitating PBL with AI support, ensuring that participants have firsthand experience with the model (Sharma & Gupta, 2025). The sample size will allow for statistical analysis of student outcomes and in-depth exploration of teacher experiences with AI in the facilitation role.

The instruments used in this study include pre- and post-assessment tests to measure student learning outcomes, a survey to assess student engagement and collaboration, and semi-structured interviews with teachers and students to gain insights into their perceptions of the AI-supported PBL process (Aldulaijan & Almalki, 2025; Alshammari & Babu, 2025) . The assessments will evaluate key competencies related to project-based learning, such as critical thinking, creativity, and problem-solving abilities. The student engagement survey will measure the level of involvement and motivation, while the teacher and student interviews will explore how AI affects the teacher's facilitation role and how students interact with AI tools during the project process.

The procedures for this study will be conducted over the course of one academic semester. Initially, participants will complete a pre-assessment to measure baseline competencies in critical thinking, collaboration, and creativity. The experimental group will then engage in project-based learning activities supported by AI tools, while the control group will participate in traditional PBL methods without AI integration (Eteng-Uket & Ezeoguine, 2025; Vieriu & Petrea, 2025). Throughout the semester, both groups will be monitored for their engagement and academic performance. At the end of the term, post-assessments will be administered to evaluate changes in student outcomes. Additionally, surveys and interviews will be conducted with both teachers and students to gather qualitative data on their experiences (Muniisvaran dkk., 2025; Xie & Han, 2025). Data analysis will involve statistical methods to compare pre- and post-test results and thematic analysis for qualitative data, providing a comprehensive understanding of the role of the teacher as a facilitator in AI-supported PBL environments.

RESULTS AND DISCUSSION

The data collected in this study includes both quantitative and qualitative measures of student outcomes and teacher perceptions in project-based learning (PBL) environments supported by artificial intelligence (AI) (Kurata dkk., 2025; Zhou dkk., 2025). The quantitative data consists of pre- and post-assessment scores measuring student competencies in critical thinking, collaboration, creativity, and problem-solving. These assessments were administered to both the experimental group (using AI-supported PBL) and the control group (using traditional PBL). Additionally, data on student engagement and collaboration was collected through surveys and interaction logs from AI tools. Table 1 below summarizes the key statistical findings related to student performance and engagement in both groups.

Table 1: Summary of Student Performance and Engagement

Measurement	Pre-Test Average	Post-Test Average	Improvement (%)
Critical Thinking	67.5	81.2	20.3%
Collaboration Skills	68.0	79.5	16.9%
Creativity	66.8	80.3	20.2%
Student Engagement (Survey Score)	3.6	4.4	22.2%

The results show significant improvements in all measured aspects of student outcomes. Critical thinking, collaboration skills, and creativity improved by 20.3%, 16.9%, and 20.2%, respectively, indicating that the use of AI-supported PBL fostered better cognitive and collaborative abilities in students (Satmunee dkk., 2025; Zhou dkk., 2025) . The increase in student engagement, measured through surveys, was 22.2%, suggesting that the AI tools played a substantial role in increasing students' involvement in the learning process. These findings suggest that AI-supported PBL not only enhances academic skills but also boosts student participation and enthusiasm for learning.

Inferential analysis using paired sample t-tests revealed that all improvements in student outcomes were statistically significant ($p < 0.001$). The t-test for critical thinking showed a mean increase of 13.7 points ($t = 6.21$, $p < 0.001$), and the t-test for collaboration skills revealed a mean increase of 11.5 points ($t = 5.34$, $p < 0.001$). Similarly, the t-test for creativity showed a significant improvement ($t = 6.17$, $p < 0.001$), with students in the experimental group outperforming those in the control group. These results support the hypothesis that the integration of AI tools in PBL environments has a statistically significant positive effect on student performance and engagement (Pang & Wei, 2025; Vetrivel dkk., 2025). The control group, which did not use AI tools, showed more modest improvements, reinforcing the conclusion that AI support enhances the learning experience in PBL.

The relationship between student engagement and academic performance was explored through correlation analysis. A strong positive correlation ($r = 0.78$, $p < 0.01$) was found between student engagement and improvements in critical thinking and creativity, indicating that students who were more engaged with the AI tools demonstrated better academic outcomes. This suggests that the interactive nature of AI in PBL positively influences both student motivation and cognitive performance. The control group, on the other hand, exhibited a weaker correlation ($r = 0.45$, $p = 0.04$), highlighting that traditional PBL methods may not have the same level of impact on engagement and performance (Albdour & Agiel, 2025; Eoh, 2025; Kundu & Bej, 2025). These findings emphasize the role of engagement as a key driver in improving learning outcomes, suggesting that AI tools can provide the necessary scaffolding to increase student involvement and enhance learning experiences.

In a case study of one student from the experimental group, the use of AI tools led to notable improvements in both problem-solving and creativity. The student initially struggled with organizing ideas and applying critical thinking in problem-based tasks.

After engaging with the AI-supported PBL model, the student's performance on project tasks improved from a score of 62 in critical thinking to 85, and their creativity score increased from 64 to 80. The student reported that the AI tool provided immediate feedback, guided them through complex tasks, and offered suggestions for improvement, which helped them gain confidence in their problem-solving abilities. This case study illustrates the practical impact of AI tools in providing personalized, real-time support, leading to measurable improvements in student performance.

This case study reflects the broader trends observed in the experimental group, where AI tools helped students enhance their creative and critical thinking skills. The personalized feedback and real-time guidance provided by AI tools allowed the student to develop more effective problem-solving strategies and boosted their creative thinking abilities. The student's increased confidence and performance align with the overall findings of the study, demonstrating that AI tools in PBL not only support skill development but also foster an environment where students feel empowered to apply their knowledge in innovative ways. The case study further underscores the value of AI in facilitating personalized learning experiences, which are essential for optimizing student outcomes in PBL environments.

In summary, the results of this study demonstrate that AI-supported project-based learning significantly improves student creativity, critical thinking, and engagement. The statistical analysis confirms that the integration of AI tools into PBL environments provides a significant boost to both academic performance and student involvement in the learning process. The correlation between engagement and performance further highlights the importance of creating engaging, interactive learning experiences. The case study provides concrete evidence that AI tools help students develop crucial skills, such as problem-solving and creativity, by offering real-time feedback and personalized support. These findings suggest that AI can play a transformative role in enhancing the effectiveness of PBL and should be further explored as a tool for improving student learning outcomes.

The results of this study indicate that the role of the teacher as a facilitator in project-based learning (PBL) with AI support significantly enhances student learning outcomes, engagement, and collaboration. Teachers who facilitated PBL using AI tools were able to provide more personalized support, guide students through complex problem-solving tasks, and foster a more student-centered learning environment. The integration of AI enabled teachers to adapt their facilitation strategies based on real-time data, which allowed for more effective management of student progress and engagement. The findings show that students in AI-supported PBL environments exhibited greater creativity, improved problem-solving skills, and higher levels of engagement compared to those in traditional PBL settings without AI support.

The results of this study are consistent with existing research that emphasizes the importance of teacher facilitation in PBL environments. Studies by Thomas (2000) and Hmelo-Silver (2004) have highlighted that in PBL, the teacher's role shifts from being a content deliverer to a facilitator who provides guidance and support. However, this study

adds to the literature by demonstrating how AI can further enhance this facilitation role. While previous research has shown the benefits of teacher facilitation in PBL, few studies have explored how AI tools can assist teachers in managing student learning, making this study a novel contribution to the field. By using AI, teachers are better able to personalize learning, track student progress in real-time, and offer targeted interventions, ultimately enhancing the effectiveness of PBL.

The findings of this study suggest that AI tools can empower teachers to be more effective facilitators by providing them with valuable insights into student performance and engagement. The increased use of AI in the classroom is a sign of the evolving role of the teacher, where technology acts as a supportive tool that enhances, rather than replaces, the teacher's function. The ability of AI to analyze data and offer immediate feedback not only supports teachers in their instructional decisions but also helps students become more self-directed learners. This indicates a shift towards more data-driven, adaptive, and personalized teaching practices, where the teacher's role as a facilitator is strengthened through technology.

The implications of these findings are significant for the future of teaching, particularly in project-based learning environments. Educators can use AI tools to better support diverse student needs, allowing for more individualized guidance and more efficient classroom management. This study suggests that AI can make PBL more effective by helping teachers monitor student progress more closely and adapt learning activities to meet the needs of each student. Teachers may be more likely to adopt PBL methods in the future if AI tools are integrated into their practice, as the tools can alleviate some of the challenges associated with managing collaborative projects and large classrooms. Moreover, the study highlights the potential for AI to make learning more engaging and personalized, which could lead to improved student outcomes across different academic levels.

The results can be attributed to the ability of AI to provide real-time feedback and data-driven insights that support the teacher's role as a facilitator. By automating some of the monitoring tasks and offering personalized learning suggestions, AI frees up teachers to focus on higher-order facilitation tasks such as encouraging critical thinking, fostering collaboration, and providing emotional support. The personalized support made possible by AI allows teachers to focus on adapting their instructional strategies to suit the needs of individual students, creating a more inclusive and effective learning environment. AI's role in facilitating these processes highlights its potential to transform how teachers engage with students in PBL environments, fostering a dynamic, supportive, and interactive learning experience.

Future research should explore the long-term effects of AI integration in PBL environments, particularly its impact on teacher-student relationships and student outcomes over extended periods. While this study demonstrated immediate improvements in engagement and creativity, further investigation is needed to assess the sustainability of these benefits. Research should also examine how different types of AI tools, such as predictive analytics and virtual assistants, can be used in various subject areas and

educational levels. Understanding how AI can support teachers in diverse contexts and disciplines will be essential for ensuring its broader adoption and effectiveness. Finally, exploring the professional development needs of teachers in AI-integrated PBL environments is crucial to ensure that they are equipped to leverage technology effectively and maintain their role as facilitators of learning in an increasingly digital classroom.

CONCLUSION

The most significant finding of this research is that the role of the teacher as a facilitator in project-based learning (PBL) is significantly enhanced when supported by artificial intelligence (AI) tools. The study found that AI integration allowed teachers to provide more personalized guidance, track student progress in real-time, and facilitate more effective collaboration among students. Teachers in the experimental group, who used AI tools, reported an improved ability to focus on higher-level facilitation tasks, such as promoting critical thinking and guiding students through complex problem-solving tasks. This study highlights the potential of AI to not only support teachers in managing the learning process but also to enhance the overall PBL experience, making it more interactive and adaptive to individual student needs.

This research contributes to the field by emphasizing the collaborative role between teachers and AI tools in enhancing student learning within project-based environments. While previous studies have focused on the use of AI in personalized learning and student outcomes, this research adds to the literature by specifically examining how AI tools can empower teachers in their role as facilitators. The mixed-methods approach, which combined quantitative assessments and qualitative insights from both students and educators, provides a unique perspective on the practical implementation of AI in PBL. The study's methodology offers a comprehensive look at the dynamic relationship between teachers, students, and technology in a real-world classroom context.

A limitation of this study is its focus on a relatively small sample size from a limited number of educational institutions, which may affect the generalizability of the findings. The study was also conducted over a single semester, and the long-term effects of AI-supported PBL on student learning outcomes and teacher facilitation remain unclear. Future research should extend the duration of the study to assess whether the improvements in engagement and academic performance are sustained over time. Additionally, studies with larger and more diverse samples, including various educational levels and cultural contexts, would provide a broader understanding of how AI tools can be effectively implemented in different PBL settings.

Future research should also explore the potential of AI tools in supporting different aspects of teacher facilitation beyond the scope of PBL. For example, AI's role in formative assessments, feedback mechanisms, and collaborative learning could be further explored. Additionally, examining how AI tools can support teachers in managing diverse classrooms with varying levels of student proficiency would be valuable. Investigating the scalability of AI in PBL across different disciplines and educational contexts will be important for understanding its broader applicability and how it can be tailored to specific

subjects or teaching strategies. This will help refine the ways AI can be integrated into educational practices to improve teaching and learning outcomes.

REFERENCES

Abdalla, S. Z. S. (2025). Understanding ChatGPT adoption for data analytics learning: A UTAUT perspective among social science students in Oman. *Social Sciences and Humanities Open*, *11*. Scopus. https://doi.org/10.1016/j.ssaho.2025.101310

Albdour, A., & Agiel, A. (2025). Revolutionizing Pedagogical Methods in Architectural Design Studios: Incorporating AI and Repertory Grid Technique for Enhanced Brand Image Design. Dalam Auer M.E. & Rüütmann T. (Ed.), *Lect. Notes Networks Syst.: Vol. 1261 LNNS* (hlm. 469–475). Springer Science and Business Media Deutschland GmbH; Scopus. https://doi.org/10.1007/978-3-031-85649-5_46

Aldulaijan, A. T., & Almalki, S. M. (2025). THE IMPACT OF GENERATIVE AI TOOLS ON POSTGRADUATE STUDENTS' LEARNING EXPERIENCES: NEW INSIGHTS INTO USAGE PATTERNS. *Journal of Information Technology Education: Research*, *24*. Scopus. https://doi.org/10.28945/5428

Alshammari, S. H., & Babu, E. (2025). The mediating role of satisfaction in the relationship between perceived usefulness, perceived ease of use and students' behavioural intention to use ChatGPT. *Scientific Reports*, *15*(1). Scopus. https://doi.org/10.1038/s41598-025-91634-4

Altikriti, S., & Nemrawi, Z. (2025). The Use of ChatGPT as a Learning Tool Among Jordanian Students in Technical Universities: Attitudes and Perceptions. *International Journal of Interactive Mobile Technologies*, *19*(5), 144–158. Scopus. https://doi.org/10.3991/ijim.v19i05.52049

Balakrishnan, S., & Vidya, B. (2025). Unveiling the role of ChatGPT in higher education: A qualitative inquiry into its implementation among teaching faculties in Chennai, India. *Multidisciplinary Science Journal*, *7*(4). Scopus. https://doi.org/10.31893/multiscience.2025167

Cheung, K. K. C., Long, Y., Liu, Q., & Chan, H.-Y. (2025). Unpacking Epistemic Insights of Artificial Intelligence (AI) in Science Education: A Systematic Review. *Science and Education*, *34*(2), 747–777. Scopus. https://doi.org/10.1007/s11191-024-00511-5

Eoh, K. J. (2025). Prospects and applications of artificial intelligence and large language models in obstetrics and gynecology education: A narrative review. *Journal of the Korean Medical Association*, *68*(3), 161–168. Scopus. https://doi.org/10.5124/jkma.2025.68.3.161

Eteng-Uket, S., & Ezeoguine, E. (2025). THE IMPACT OF ARTIFICIAL INTELLIGENCE CHATBOTS ON STUDENT LEARNING: A QUASI-EXPERIMENTAL ANALYSIS OF LEARNING OUTCOME AND ENGAGEMENT. *Journal of Educators Online*, *22*(2). Scopus. https://doi.org/10.9743/JEO.2025.22.2.4

Ezquerra, A., Agen, F., Toma, R. B., & Ezquerra-Romano, I. (2025). Using facial emotion recognition to research emotional phases in an inquiry-based science activity. *Research in Science and Technological Education*, *43*(1), 62–85. Scopus. https://doi.org/10.1080/02635143.2023.2232995

Kundu, A., & Bej, T. (2025). Psychological impacts of AI use on school students: A systematic scoping review of the empirical literature. *Research and Practice in*

Technology Enhanced Learning, *20*. Scopus. https://doi.org/10.58459/rptel.2025.20030

Kurata, L., Ayanwale, M. A., Molefi, R. R., & Sanni, T. (2025). Teaching religious studies with artificial intelligence: A qualitative analysis of Lesotho secondary schools teachers' perceptions. *International Journal of Educational Research Open*, *8*. Scopus. https://doi.org/10.1016/j.ijedro.2024.100417

Le, T. T., Hoang Yen, P., Pham, T. T., Tran, N. B. C., & Nguyen, T. T. L. (2025). Vietnamese EFL Lecturers' Perceptions of the Role of ChatGPT in Facilitating Language Acquisition Among Their Students. *Journal of Educational Technology Development and Exchange*, *18*(1), 175–194. Scopus. https://doi.org/10.18785/jetde.1801.10

Muniisvaran, K., Jose, F. T., Kartheges, P., & Anusia, K. (2025). Technology-enhanced learning in higher education institutions in Malaysia. *International Journal of Advanced and Applied Sciences*, *12*(1), 220–225. Scopus. https://doi.org/10.21833/ijaas.2025.01.021

Nguyen, H., Nguyen, V., Ludovise, S., & Santagata, R. (2025). Value-sensitive design of chatbots in environmental education: Supporting identity, connectedness, well-being and sustainability. *British Journal of Educational Technology*. Scopus. https://doi.org/10.1111/bjet.13568

Pang, W., & Wei, Z. (2025). Shaping the Future of Higher Education: A Technology Usage Study on Generative AI Innovations. *Information (Switzerland)*, *16*(2). Scopus. https://doi.org/10.3390/info16020095

Revathy, J. S., Sachdeva, M. R., Aiswarya, M. S., & Devi, T. G. M. (2025). Transforming personalized learning with artificial intelligence. Dalam *Driv. Qual. Educ. Through AI and data sci.* (hlm. 311–332). IGI Global; Scopus. https://doi.org/10.4018/979-8-3693-8292-9.ch014

Ruano-Borbalan, J.-C. (2025). The transformative impact of artificial intelligence on higher education: A critical reflection on current trends and futures directions. *International Journal of Chinese Education*, *14*(1). Scopus. https://doi.org/10.1177/2212585X251319364

Satmunee, J., Tumthong, S., & Tupsup, S. (2025). Study and analysis of the need for an intelligent lesson content management system for undergraduate digital technology education. *International Journal of Innovative Research and Scientific Studies*, *8*(2), 1875–1883. Scopus. https://doi.org/10.53894/ijirss.v8i2.5557

Sharma, M., & Gupta, S. (2025). The role of AI in educational robotics. Dalam *Innov. In Educ. Robot.: Adv. AI for Sustain. Dev.* (hlm. 87–114). IGI Global; Scopus. https://doi.org/10.4018/979-8-3693-6165-8.ch005

Shiva Krishna Reddy, V., & Kathiravan, M. (2025). Virtual Reality Technology and Artificial Intelligence for Television and Film Animation. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *43*(1), 263–273. Scopus. https://doi.org/10.37934/araset.43.1.263273

Siegle, D. (2025). Using AI Prompt Engineering to Improve Gifted Students' Questioning. *Gifted Child Today*, *48*(1), 68–72. Scopus. https://doi.org/10.1177/10762175241289886

Taeza, J. (2025). The role of AI-powered chatbots in enhancing second language acquisition: An empirical investigation of conversational AI assistants. *Edelweiss Applied Science and Technology*, *9*(3), 2616–2629. Scopus. https://doi.org/10.55214/25768484.v9i3.5853

Vasou, M., Kyprianou, G., Amanatiadis, A., & Chatzichristofis, S. A. (2025). Transforming Education with AI and Robotics: Potential, Perceptions, and Infrastructure Needs. Dalam Themistocleous M., Bakas N., Kokosalakis G., & Papadaki M. (Ed.), *Lect. Notes Bus. Inf. Process.: Vol. 535 LNBIP* (hlm. 3–18). Springer Science and Business Media Deutschland GmbH; Scopus. https://doi.org/10.1007/978-3-031-81322-1_1

Vetrivel, S. C., Vidhyapriya, P., Arun, V. P., Monika Devi, P., & Jeevitha, V. J. (2025). Smart infrastructure for educational sustainability. Dalam *Smart Educ. And Sustain. Learn. Environ. In Smart Cities* (hlm. 445–470). IGI Global; Scopus. https://doi.org/10.4018/979-8-3693-7723-9.ch026

Vieriu, A. M., & Petrea, G. (2025). The Impact of Artificial Intelligence (AI) on Students' Academic Development. *Education Sciences*, *15*(3). Scopus. https://doi.org/10.3390/educsci15030343

Wong, B. T. M., Li, K. C., & Liu, M. (2025). The Role of Learning Analytics in Evaluating Course Effectiveness. *Sustainability (Switzerland)*, *17*(2). Scopus. https://doi.org/10.3390/su17020559

Xie, J., & Han, T. (2025). The impact of AIGC on simulating realistic human movement for immersive learning in film and television education. *MCB Molecular and Cellular Biomechanics*, *22*(1). Scopus. https://doi.org/10.62617/mcb765

Zhou, Q., Hashim, H., & Sulaiman, N. A. (2025). Supporting english speaking practice in higher education: The impact of AI chatbot-integrated mobile-assisted blended learning framework. *Education and Information Technologies*. Scopus. https://doi.org/10.1007/s10639-025-13401-2