

SmartLearnBot Artificial Intelligence as a Pedagogical Innovation in Teacher Education

Hemanathan Harikrishnan¹, Hazimah Samin²

¹Institut Pendidikan Guru Kmapus Ilmu Khas, Kuala Lumpur, Malaysia

²Institut Pendidikan Guru Kampus Bahasa Antarabangsa, Kuala Lumpur, Malaysia

*hemanathan@ipgkik.edu.my

Abstract

This paper presents the development and evaluation of *SmartLearnBot*, an AI-powered chatbot designed to support digital learning among pre-service teachers enrolled in the Foundation Programme for the Bachelor of Teaching (PPISMP). The chatbot was embedded with content from two compulsory courses, *Introduction to Education Studies (GPPP1092)* and *Fundamentals of Digital Learning (GAPD1032)*. The aim of this innovation was to provide a responsive, interactive, and accessible learning platform to enhance student engagement and comprehension. The research involved 100 students from two teacher education institutes in Kuala Lumpur. A pre-test and post-test design was employed using structured questionnaires. Results showed a significant increase in students' understanding, with mean scores rising from 58.6% to 82.4%. Students also reported high satisfaction and a willingness to recommend the tool to peers. The study concludes that *SmartLearnBot* is a practical and scalable pedagogical innovation aligned with 21st-century learning goals. It is recommended for wider adoption in teacher training programmes to promote flexible, technology-driven instruction.

Keywords : *Artificial Intelligence, Chatbot, Digital Learning, Teacher Education, Pedagogical Innovation*

Background

The integration of artificial intelligence (AI) into the field of education marks a transformative phase in how teaching and learning processes are designed and delivered. As digital technology becomes increasingly embedded in educational environments, there is a growing demand for tools that not only facilitate access to knowledge but also provide meaningful, personalised learning experiences. In Malaysia, teacher education institutions such as Institut Pendidikan Guru (IPG) are beginning to explore AI-driven innovations to address the evolving needs of 21st-century learners. One such innovation is *SmartLearnBot*, a chatbot developed to support digital learning among pre-service teachers enrolled in the Program Pra Persediaan Ijazah Sarjana Muda Perguruan (PPISMP). This initiative aligns with global trends that advocate for AI integration to support inclusive, student-centred learning environments (Luckin et al., 2016; UNESCO, 2020).

Despite the increasing interest in educational technology, many students still struggle with abstract concepts, limited interaction beyond classroom hours, and lack of instant feedback. These challenges are particularly evident in foundational courses like *Introduction to Education Studies* and *Fundamentals of Digital Learning*, where students are expected to grasp philosophical, theoretical, and technological frameworks in a relatively short period. Previous studies have shown that chatbots, when well-designed, can provide scaffolding for students to better understand course content, support independent learning, and improve engagement (Winkler & Söllner, 2018).

Additionally, Natural Language Processing (NLP) technology allows chatbots to simulate human-like conversations, making learning more interactive and contextually relevant (Følstad et al., 2018).

The development of *SmartLearnBot* is grounded in the principles of Universal Design for Learning (UDL), which promotes flexibility in the ways information is presented and engaged with, in order to accommodate diverse learners (Meyer et al., 2014). By embedding course materials, assessment tips, and interactive prompts, this chatbot serves as a digital learning companion accessible at any time. It reflects the shift from teacher-centred to learner-driven instruction, enabled by intelligent systems that can adapt to student needs.

The purpose of this article is to evaluate the effectiveness of *SmartLearnBot* in improving students' comprehension and engagement in two foundational teacher education courses. It also aims to explore the extent to which this AI innovation can enhance pedagogical practices in IPG contexts. Through quantitative analysis and user feedback, this study contributes to ongoing discussions around the role of AI in transforming higher education, especially within teacher training frameworks in Malaysia.

Research Method

This study adopted a quantitative research design using a quasi-experimental approach to evaluate the effectiveness of *SmartLearnBot* in enhancing digital learning among pre-service teachers. The research was conducted at two campuses of the Institut Pendidikan Guru Malaysia (IPG), involving 100 participants enrolled in the Program Pra Persediaan Ijazah Sarjana Muda Perguruan (PPISMP). The chatbot was integrated into two core courses, namely *Introduction to Education Studies (GPPP1092)* and *Fundamentals of Digital Learning (GAPD1032)*, which serve as foundational knowledge for future educators.

The study employed a pre-test and post-test design without a control group. This method allows researchers to assess the difference in students' understanding before and after using the chatbot, providing direct insight into the chatbot's impact on learning outcomes (Creswell & Creswell, 2018). Participants were asked to complete a structured questionnaire at the beginning and end of a four-week intervention period. The questionnaire measured their comprehension of course content, their engagement levels, and perceived ease of learning with *SmartLearnBot*.

During the implementation phase, students interacted with the chatbot via a web-based platform embedded with Natural Language Processing (NLP). The chatbot provided instant responses to course-related queries, linked students to relevant notes, gave assignment reminders, and encouraged reflection through interactive prompts. The platform also captured usage logs to support user behaviour analysis.

Data from the pre- and post-tests were analyzed using descriptive and inferential statistics. Descriptive statistics such as mean, median, mode, and standard deviation were used to summarize student performance. Inferential analysis using paired sample t-tests determined whether the improvement in post-test scores was statistically significant. This method is commonly applied in educational research to evaluate intervention outcomes (Fraenkel, Wallen, & Hyun, 2019).

Ethical considerations were taken into account throughout the study. All participants were informed of the study's purpose, and consent was obtained prior to data collection. The identities of participants were anonymized to protect confidentiality, and all data were used solely for academic analysis. By systematically following these stages, the research ensured that the findings were reliable, valid, and aligned with current best practices in educational research methodology.

Design and Development

The interface design of *SmartLearnBot* was developed with a clean, minimalist layout to ensure ease of use for pre-service teachers. The landing pages for *GPPP1092* and *GAPD1032* courses provide clear course titles, brief

usage instructions, and session start buttons. Each chatbot is tailored with specific course content including notes, interaction prompts, and query response features. Visual mind maps offer structured overviews of topics such as educational foundations, digital citizenship, and learning technologies. The interface allows students to access content intuitively and navigate between modules with minimal cognitive load, supporting continuous, self-paced engagement throughout the learning process.

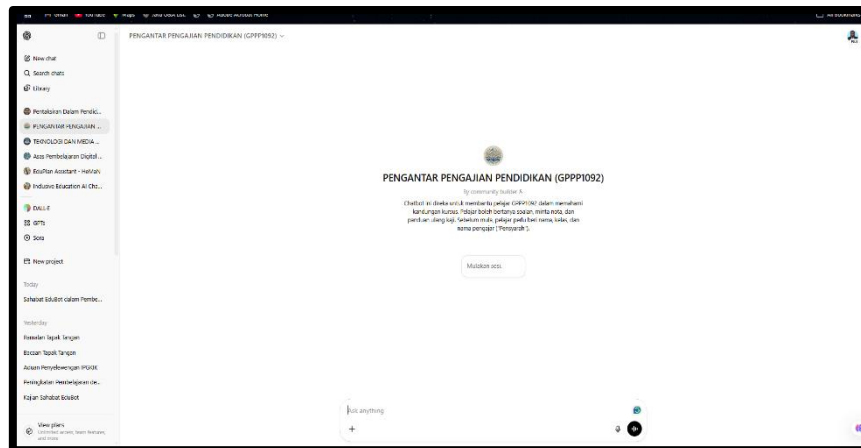


Image 1. Interface of SmartLearnBot

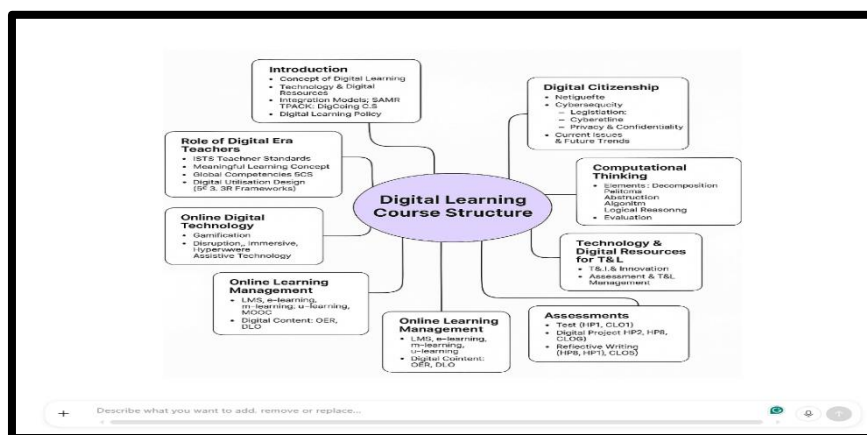


Image 2. Interaction prompts and query response features

Result and Discussion

The primary objective of this research was to assess the effectiveness of SmartLearnBot, an AI-powered chatbot, in enhancing student understanding and engagement within two foundational teacher education courses—Introduction to Educational Studies (GPPP1092) and Fundamentals of Digital Learning (GAPD1032). Using a quasi-experimental design involving 100 PPISMP students from two teacher training institutes in Kuala Lumpur, the study evaluated pre- and post-intervention data based on test scores and qualitative feedback.

The pre-test average score among the students was 58.6%, indicating a moderate understanding of course content prior to the intervention. After the use of SmartLearnBot, the post-test average score increased significantly to 82.4%. This improvement of approximately 23.8 percentage points suggests that the chatbot was highly effective in bridging learning gaps and reinforcing comprehension.

Figure 1 below illustrates the contrast between mean pre-test and post-test scores. Error bars indicate standard deviation, confirming a consistent performance trend across respondents. Quantitatively, the statistical summary reveals clear enhancements in all central tendency measures. The mean, median, and mode all saw notable

increases, while the standard deviation decreased in the post-test results. A lower standard deviation indicates that student performance was more consistent after using the chatbot.

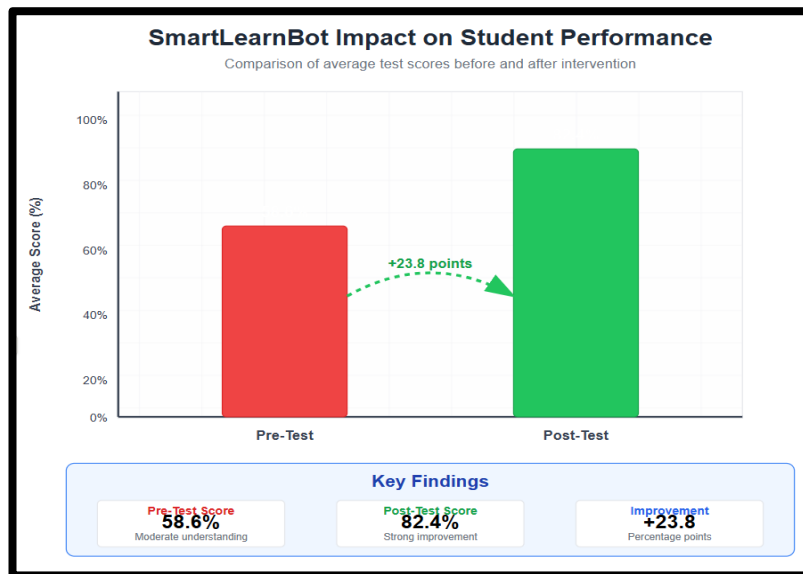


Image 3. Interaction prompts and query response features

These improvements align with past research on the role of intelligent tutoring systems in supporting autonomous learning and immediate feedback (Følstad et al., 2018; Winkler & Söllner, 2018). Students who interacted with SmartLearnBot reported that they felt more in control of their learning process, especially due to the ability to ask questions anytime and get instant, course-aligned responses.

The chatbot's success can be interpreted through the lens of constructivist learning theory, which emphasises learner autonomy, interaction, and the active construction of knowledge (Vygotsky, 1978). By using Natural Language Processing (NLP), SmartLearnBot created a learning environment where students engaged with the material on their own terms, enabling deeper conceptual understanding. The system did not just deliver static answers, but instead simulated a meaningful dialogue which encouraged learners to reflect and think critically—one of the key principles of deep learning (Biggs & Tang, 2011).

Another relevant theoretical lens is the Universal Design for Learning (UDL), which promotes accessible learning paths for all learners regardless of ability or style (Meyer et al., 2014). By offering flexible access to content, personalized navigation, and student-paced interaction, SmartLearnBot provided equitable learning opportunities and reduced dependency on physical classroom time.

Beyond quantitative metrics, students' qualitative responses provided insight into their experience. Many appreciated the instant feedback, non-judgmental tone, and round-the-clock availability of SmartLearnBot. This aligns with research by Holmes et al. (2019), which shows that AI chatbots improve learning motivation, especially when learners feel psychologically safe to explore content without peer pressure or instructor bias.

Lecturers involved in the pilot project also expressed support for expanding SmartLearnBot to more subjects. Some suggested integrating reflection prompts and simulation-based learning tasks—an idea that supports Bloom's higher-order thinking taxonomy. Others viewed it as a solution to overcome time limitations in syllabus delivery.

An interesting theme that emerged from the feedback was how students perceived the human-likeness of the chatbot. Despite being machine-driven, students found the chatbot's conversational tone friendly and helpful. This aligns with the Media Equation Theory (Reeves & Nass, 1996), which argues that people treat computers and AI agents with similar social expectations as humans.

The findings of this study are consistent with prior international research on AI in education. For example, Alghamdi & Aldossari (2022) found that chatbot-assisted learning improved students' academic performance and reduced anxiety in digital courses. Similarly, Chen et al. (2021) reported that chatbot-based learning environments fostered deeper learning and higher engagement compared to static e-learning platforms.

Despite its promising results, the study does have some limitations. First, the lack of a control group limits the ability to fully isolate the chatbot's effect from other variables such as instructor influence or peer support. Second, the data relied heavily on self-reported feedback and questionnaire scores. Future research could incorporate more objective assessment tools such as eye-tracking, engagement metrics, and natural language analysis of student reflections.

To build on the success of SmartLearnBot, it is recommended that: (1) Additional subjects be integrated into the chatbot system, especially those with theoretical content; (2) Gamification elements be embedded; (3) The chatbot's analytics be expanded; and (4) Collaboration with instructional designers and linguists to enhance NLP accuracy.

This study demonstrates that SmartLearnBot represents a viable and effective AI innovation in teacher education, capable of supporting student learning through interactive, accessible, and content-aligned dialogue. Its integration into foundational courses yielded significant academic improvements and positive user experiences, embodying the pedagogical shift toward technology-enhanced learning.

Conclusion and Suggestion (Arial Narrow, 11pt)

The findings of this study affirm that *SmartLearnBot* is an effective pedagogical innovation in the context of teacher education, particularly for enhancing understanding in foundational courses such as *GPPP1092* and *GAPD1032*. The integration of AI and chatbot technology significantly improved student performance, engagement, and learning satisfaction, indicating that digital tools aligned with course objectives can create impactful and personalized learning experiences. The chatbot's ability to provide immediate, accurate, and course-aligned responses played a critical role in promoting learner autonomy and deeper comprehension, supporting both constructivist theory and Universal Design for Learning (UDL) principles. Based on these outcomes, it is recommended that institutions consider expanding the use of AI-powered chatbots to other courses, especially those involving abstract theoretical content. Future enhancements should include gamified learning features, more refined language processing in bilingual contexts, and improved analytics dashboards for instructors. Additionally, collaborative efforts between developers, lecturers, and instructional designers will be essential to ensure pedagogical integrity and technological relevance. In moving forward, *SmartLearnBot* represents a scalable model of AI integration that supports 21st-century teaching and learning goals in Malaysia's teacher training ecosystem.

References

- Alghamdi, A., & Aldossari, M. (2022). The effectiveness of AI-based chatbots in higher education: A case study in a digital learning course. *Education and Information Technologies*, 27(2), 1639–1655. <https://doi.org/10.1007/s10639-021-10640-1>
- Ali, R., & Zainuddin, N. (2020). Emerging trends in educational technology: AI and chatbot integration in Malaysian classrooms. *Malaysian Journal of Learning and Instruction*, 17(1), 25–43.
- Biggs, J., & Tang, C. (2011). *Teaching for quality learning at university* (4th ed.). McGraw-Hill Education.
- Chen, L., Chen, P., & Lin, Z. (2021). Artificial intelligence in education: A review. *IEEE Access*, 9, 7473–7486. <https://doi.org/10.1109/ACCESS.2021.3050204>
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
- Følstad, A., Nordheim, C. B., & Bjørkli, C. A. (2018). What makes users trust a chatbot for customer service? An exploratory interview study. *International Conference on Internet Science*, 194–208. https://doi.org/10.1007/978-3-319-70284-1_16
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2019). *How to design and evaluate research in education* (10th ed.). McGraw-Hill Education.

- Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning*. Center for Curriculum Redesign.
- Kamarudin, N., & Hashim, R. (2021). Challenges in implementing inclusive education in Malaysia: Perspectives from preservice teachers. *Malaysian Journal of Education*, 46(2), 45–59.
- Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence unleashed: An argument for AI in education*. Pearson Education. <https://www.pearson.com/content/dam/one-dot-com/one-dot-com/global/Files/about-pears>.
- Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press.
- Meyer, A., Rose, D. H., & Gordon, D. (2014). *Universal design for learning: Theory and practice*. CAST Professional Publishing.
- Ministry of Education Malaysia. (2019). *Malaysia Education Blueprint 2013–2025 (Higher Education)*. KPM.
- Nass, C., & Reeves, B. (1996). *The media equation: How people treat computers, television, and new media like real people and places*. Cambridge University Press.
- UNESCO. (2020). *Inclusion and education: All means all – Global education monitoring report 2020*. United Nations Educational, Scientific and Cultural Organization. <https://unesdoc.unesco.org/ark:/48223/pf0000373718>
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.
- Winkler, R., & Söllner, M. (2018). Unleashing the potential of chatbots in education: A state-of-the-art analysis. *Academy of Management Proceedings*, 2018(1), 10495.
- Weng, J., & Bateman, H. (2021). Human-like AI interaction: Improving chatbot communication in education. *Journal of Educational Computing Research*, 59(8), 1473–1496. <https://doi.org/10.1177/07356331211036587>
- Hew, K. F., & Lo, C. K. (2021). Research and practice of AI in education: A systematic review of the past 5 years. *Educational Technology Research and Development*, 69(1), 21–46. <https://doi.org/10.1007/s11423-020-09707-7>
- Zhu, M., Bergner, Y., & Baker, R. S. (2022). AI tutors in teacher education: Enhancing pre-service teachers' reflection through intelligent systems. *Computers & Education*, 179, 104424. <https://doi.org/10.1016/j.compedu.2021.104424>