Development of Artificial Intelligence (AI)-Based Chatbots to Support Independent Learning in the Distance Education System

Suryo Prabowo, Abd Ghofur, Andayani*,Bramianto Setiawan

Universitas Terbuka, South Tangerang, Indonesia
*Corresponding author, email: anda@ut.ac.id

https://doi.org/10.17977/um065.v7.i5.2027.12

Article History
Submitted: 18 August 2026
Revised: 25 October 2026
Accepted: 5 November 2026
Published: 7 November 2026

Keywords
Artificial intelligence
Chatbot AI
Distance education
Educational design research
Independent learning

Abstract
The increasing use of artificial intelligence (AI) in higher education offers opportunities for flexible academic support in distance education. However, independent learners often struggle to obtain immediate clarification, contextual explanations, guided assistance, and responsive feedback outside scheduled lecturer interactions. This study developed and evaluated a course-oriented AI chatbot as structured pedagogical support for geographically distributed distance learners, focusing on validity, practicality, usability, and perceived support for independent learning. Educational Design Research (EDR) comprised three phases: Analysis and Exploration, Design and Construction, and Evaluation and Reflection. Participants included 100 undergraduate students from four regional learning centers from Bandung, Purwokerto, Bogor, and Yogyakarta, Indonesia with 25 students per center, alongside three expert validators. Data were collected through needs-analysis questionnaires, expert-validation instruments, practicality and usability questionnaires, and independent-learning support questionnaires. The needs analysis identified strong demand for flexible access, contextual examples, immediate feedback, and guided learning. Expert validation produced an overall Aiken's V coefficient of 0.90, indicating high validity. The overall practicality and usability score was 89%, with learning flexibility receiving the highest rating. Student responses were relatively consistent across the four centers. These findings support the chatbot's validity, practicality, and usability and indicate favorable perceptions of its support for independent learning. The study's contribution lies in designing course-oriented AI support as a pedagogical scaffold intended to strengthen learner agency. Further research should examine its effects on independent-learning behaviors and academic outcomes.

1. Introduction

The rapid development of artificial intelligence (AI) has changed the way students access knowledge, interact with learning resources, and manage academic activities. This transformation is becoming increasingly relevant in distance higher education, because students are required to have a relatively high level of learning independence while being geographically separated from lecturers and peers. Bond et al. (2024) show that the application of AI in higher education is increasingly leading to adaptive systems, personalization, automated support, and student-centered services, although the pedagogical and ethical foundations are still not fully evenly distributed. Labadze et al. (2023) also reported that AI chatbots are able to provide direct assistance, accelerate access to information, provide personalized responses, and provide continuous learning support. Kuhail et al. (2023) show that educational chatbots have been used in various disciplines and interaction models, indicating the increasing potential of chatbots as conversation-based learning interfaces rather than simply as static information providers. Chan and Hu (2023) found that students view generative AI as beneficial in supporting personalized learning, brainstorming, academic writing, research, and analysis, although they also raised concerns regarding accuracy, privacy, and ethical use. McGrath et al. (2025) further observed that AI chatbots have come a long way in higher education, but empirical research still does not have a consistent conceptual foundation regarding how the technology mediates the human learning process. This development presents an important challenge for higher education, namely the need for universities to move beyond the informal use of versatile AI by students towards the development of AI-assisted learning environments that are intentionally designed to support independent, responsible, and academically meaningful learning.

Independent learning is an important element in distance education because students must be able to manage learning time, identify learning difficulties, find relevant explanations, evaluate understanding, and

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

make decisions about the next learning activity without continuous face-to-face assistance. AI chatbots have the potential to be an appropriate medium because conversation-based interactions allow students to get learning help when needed, not just when lecturers are available. Ali et al. (2023), through the development of TeacherGAIA, show that generative AI chatbots can be designed to support self-paced learning and self-assessment through knowledge construction, inquiry processes, cognitive guidance, and asynchronous interactions. Lee et al. (2022) report that the use of AI-based chatbots by students can support post-learning material review activities and is related to changes in academic achievement, self-efficacy, learning attitudes, and motivation. Jo (2024) further identifies personalization and knowledge acquisition as important components that shape the perception of benefits and intentions of student behavior in using AI chatbots. Lin et al. (2025) show that the effectiveness of learning chatbots depends on how conversational patterns are intentionally aligned with the learning design, rather than simply providing automated responses to student questions. Abbas et al. (2024), on the other hand, show that uncontrolled use of generative AI may be related to unfavorable consequences, such as procrastination, memory difficulties, and decreased academic performance when students become overly dependent on the technology.

This problem is becoming increasingly important in the Research Methodology course. Students are required to understand the conceptual relationship between research problems, theoretical foundations, variables, research design, sampling techniques, instruments, validity, reliability, data collection, and data analysis. These concepts require the ability to interpret and methodological reasoning, not just remember definitions. Common chatbots that directly generate final answers have the potential to reduce student cognitive engagement. On the other hand, chatbots that are specifically designed according to the needs of the course can function as a learning medium that provides explanations, instructions, examples, clarification questions, and guided feedback. This kind of design places AI as an academic companion that supports the learning process, while methodological decisions remain in the control of students. The scientific rationale of this research, thus, lies in the need to develop an AI chatbot whose pedagogical function is deliberately linked to independent learning in the context of certain courses and educational systems.

Research on AI chatbots in higher education can be grouped into three parts, namely chatbot-assisted learning, acceptance and use of AI by students, and responsible pedagogical integration. Studies on chatbot-assisted learning generally emphasize the aspects of accessibility, interaction, personalization, and direct feedback. Labadze et al. (2023) synthesize a range of evidence suggesting that educational chatbots can improve access to learning support as well as contribute to learning achievement, reasoning ability, and knowledge retention, although their effects on learning motivation and engagement still show mixed results. Kuhail et al. (2023) found considerable variation in chatbot platforms, conversation design, learning functions, and evaluation procedures. The findings show that the effectiveness of education is strongly influenced by context as well as interaction design. Ali et al. (2023) show that prompt engineering can be used to direct generative AI interactions to self-learning and self-assessment rather than just delivering conventional answers. Lin et al. (2025) also emphasized that interaction logs and conversation patterns can be analyzed to refine the design of learning chatbots and connect the technology's functions to the expected learning process. McGrath et al. (2025) concluded that the rapid growth of research on AI chatbots has not resulted in a sufficiently coherent theoretical explanation of how interactions with chatbots contribute to student learning.

Second, it is related to student admissions and the use of AI in academic activities. Habibi et al. (2023), examined the acceptance and use of ChatGPT by students and showed that AI adoption has become an increasingly relevant issue in Indonesian universities. Malik et al. (2023) found that higher education students in Indonesia view AI as useful in supporting academic essay writing activities. The findings show that AI-assisted academic practices have entered students' daily learning experiences. Nagy et al. (2024) examine the adoption of AI in higher education and emphasize the importance of understanding the institutional and individual conditions behind the application of AI technology. Sustaningrum and Haldaka (2025) also examine students' use and perceptions of AI for academic purposes, which shows the need to understand how students utilize AI technology in a real academic environment. Chan and Hu (2023) found that college students appreciate the personalization and academic assistance aspects that AI offers, but at the same time need clearer guidelines regarding its reliability and ethics.

Third, risks and pedagogical responsibilities. Bond et al. (2024) emphasize the need for methodological rigor, sensitivity to context, attention to ethical aspects, as well as stronger cross-disciplinary collaboration in AI research in higher education. Jo (2024) identifies concerns about privacy and technophobia as barriers that can affect students' acceptance of AI chatbots. Abbas et al. (2024) provide empirical evidence that the intensive use of generative AI can have unfavorable academic consequences if technology replaces, rather than supports, student learning efforts. McGrath et al. (2025) argue that evolving discourses often move between overly optimistic and overly pessimistic views of AI, while empirical evidence that is truly based on pedagogical considerations is still relatively limited. Malik et al. (2023) also show that students' positive perceptions of the use of AI in academic work need to be understood along with the issue of originality, accuracy, and responsible academic use. These three trends show that the main problem is no longer whether students will use AI, but

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

how AI can be deliberately designed as a learning medium that still maintains students' independence, control, and intellectual involvement.

A number of gaps can be identified from the existing literature. First, most international research still focuses on versatile platforms such as ChatGPT, students' perceptions of AI, adoption intentions, or the impact of learning in general. Chan and Hu (2023) explicitly recommend research involving more diverse disciplines, educational backgrounds, cultural contexts, and learning outcomes. McGrath et al. (2025) identified a limited conceptual foundation in empirical research on generative AI chatbots, especially theories that explain how chatbot interactions mediate the learning process. Labadze et al. (2023) emphasized that existing research tends to focus on short-term outcomes and has not paid adequate attention to variations in learners' characteristics and educational contexts. Kuhail et al. (2023) found that educational chatbot research tends to be concentrated in several specific discipline areas so that other academic contexts are still relatively underexplored. Bond et al. (2024) further call for the need for stronger attention to context and methodology in research on the application of AI in higher education.

The literature in Indonesia is increasingly documenting the acceptance of AI and its general use in academic activities, but evidence on the development of AI chatbots that are systematically and specifically designed for a course in the distance education system is limited. Habibi et al. (2023) examined the acceptance and use of ChatGPT by higher education students in Indonesia, rather than developing a learning chatbot specifically designed for instructional purposes. Malik et al. (2023) focused on students' perspectives on the use of AI in academic essay writing so that it better describes existing patterns of AI use than testing structured chatbots designed for a specific course. Nagy et al. (2024) examine the adoption of AI at the higher education level from a more general perspective, rather than examining AI media that are specifically geared towards self-learning. Sustaningrum and Haldaka (2025) examine the use and perception of students towards AI for academic purposes. Their findings again show the increasing use of AI without fully answering the problem of pedagogical design. Lin et al. (2025) emphasize the importance of chatbot interactions designed according to learning objectives, suggesting that instructional alignment is still an important aspect that requires empirical development in various course contexts.

A more specific gap thus lies in the wedge between AI chatbot development, self-learning, Research Methodology learning, and distance higher education in Indonesia. Research on how AI chatbots can be specifically designed as a learning medium for students who take the same courses but are spread across various regional education service centers is still limited. This research seeks to fill this gap through the development of an AI-based chatbot that is specifically aligned with the Research Methodology material and the characteristics of independent learning in the distance education system. The novelty of the research lies in the shift in focus from just the adoption of AI to the development and evaluation of course-specific conversational media education in the context of multiregional distance education in Indonesia.

Ali et al. (2023) show that generative chatbot interactions can be deliberately designed to support the self-paced learning process. Lin et al. (2025) emphasize the importance of aligning chatbot conversations with clear instructional goals. Jo (2024) shows that personalization and perception of learning benefits are important factors in student engagement with AI chatbots. Bond et al. (2024) emphasized that contextual research and methodological rigor are needed to develop AI studies in higher education. Abbas et al. (2024) show why such a pedagogical structure is necessary, as uncontrolled reliance on generative AI can interfere with productive learning behaviors. Based on this description, the purpose of this research is to develop and evaluate Artificial Intelligence (AI)-based chatbots as a learning medium to support independent learning in Research Methodology courses in the distance education system.

2. Method

2.1. Research Design

This study employed Educational Design Research (EDR) with a predominantly quantitative approach to develop and evaluate an Artificial Intelligence (AI)-based chatbot designed to support independent learning in a Research Methodology course within a distance education context. EDR was selected because it enables educational interventions to be systematically and iteratively developed through interconnected processes of analysis, design, implementation, evaluation, and refinement. It also provides a framework for linking contextual educational needs, theoretical foundations, intervention design, and empirical evaluation in higher education settings (Cela-Ranilla et al., 2025).

The EDR process comprised three main stages: (1) Analysis and Exploration, (2) Design and Construction, and (3) Evaluation and Reflection. The Analysis and Exploration stage focused on identifying students' learning characteristics, difficulties, independent learning needs, prior experiences with AI, and expectations regarding chatbot-supported learning. The Design and Construction stage involved designing and developing the chatbot, conducting internal testing, obtaining expert validation, and revising the prototype. Finally, the Evaluation and

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

Reflection stage involved implementing the revised chatbot with students, evaluating its practicality, usefulness, and support for independent learning, reflecting on user feedback, and refining the final product. The three stages of the EDR process and their interrelationships are illustrated in Figure 1.

A predominantly quantitative approach was applied during the evaluation stage to generate empirical evidence from expert validation and student questionnaire data, while qualitative feedback was used to support the interpretation of the findings and identify areas for product refinement. This design was considered appropriate for AI-based educational media development because the quality and usability of such interventions depend on the alignment among technological features, learning objectives, learner characteristics, and the context in which the technology is implemented (Luo et al., 2025; Weng et al., 2024).

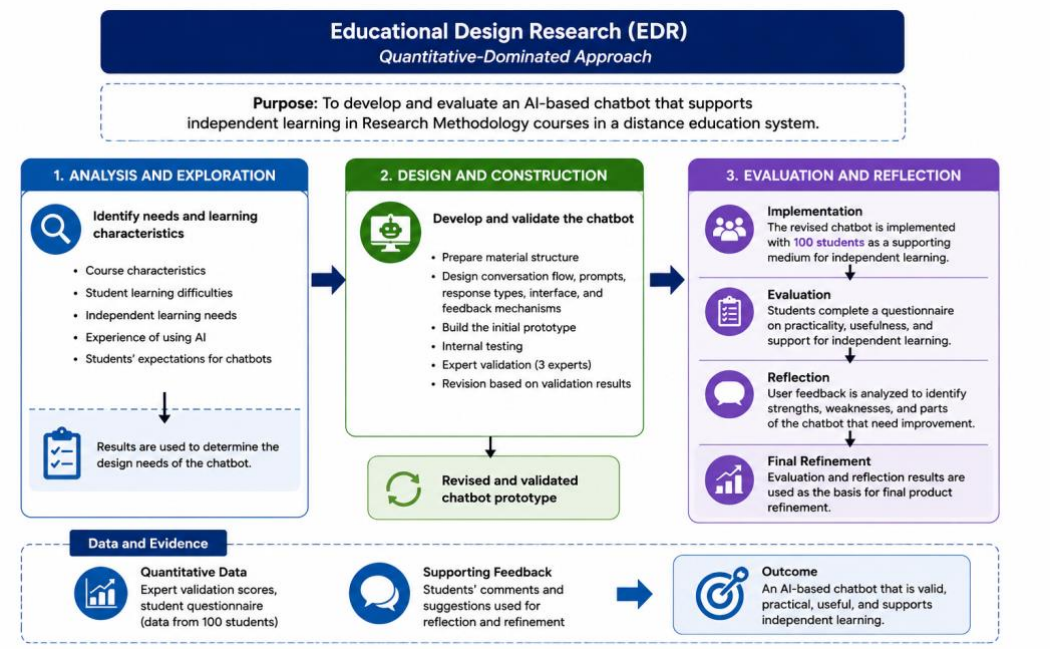


Figure 1. Research Design and Relationships Among the Three EDR Stages

2.2. Participants and Sampling Techniques

The study involved 100 undergraduate students from the Faculty of Teacher Training and Education who were enrolled in the Research Methodology course. Participants were recruited from four regional offices, with an equal distribution of 25 students from Bandung, 25 from Purwokerto, 25 from Bogor, and 25 from Yogyakarta. This multi-regional distribution was intended to capture students' experiences with the AI-based chatbot across geographically diverse distance education contexts.

Participants were selected using purposive sampling based on predetermined inclusion criteria. Eligible participants were required to: (1) be active undergraduate students, (2) be enrolled in the Research Methodology course during the study period, (3) have access to an internet-connected device, and (4) be willing to participate in the entire chatbot implementation and evaluation process. The purposive sampling strategy ensured that all participants had the necessary academic and technological conditions to engage with and evaluate the developed chatbot.

2.3. Research Instruments

The research instruments consisted of a needs analysis questionnaire, an expert validation instrument, a questionnaire on the practicality and usefulness of chatbots, and a questionnaire on independent learning support. Product validation involves three experts, namely Research Methodology experts, learning technologists, and AI or technology-assisted learning experts. The assessment uses a five-point scale and is analyzed with Aiken's V. Validation values are in the range of 0.83–0.96, with an average of about 0.90, indicating a high level of content validity.

The student questionnaire uses a five-point Likert scale from 1 = strongly disagree to 5 = strongly agree. The aspects measured included ease of access, navigation, clarity of response, relevance of answers, system responsiveness, support for concept understanding, learning flexibility, and independent learning.

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

2.4. Research Procedure

The research procedure consisted of three main stages: Analysis and Exploration, Design and Construction, and Evaluation and Reflection (see Figure 2).

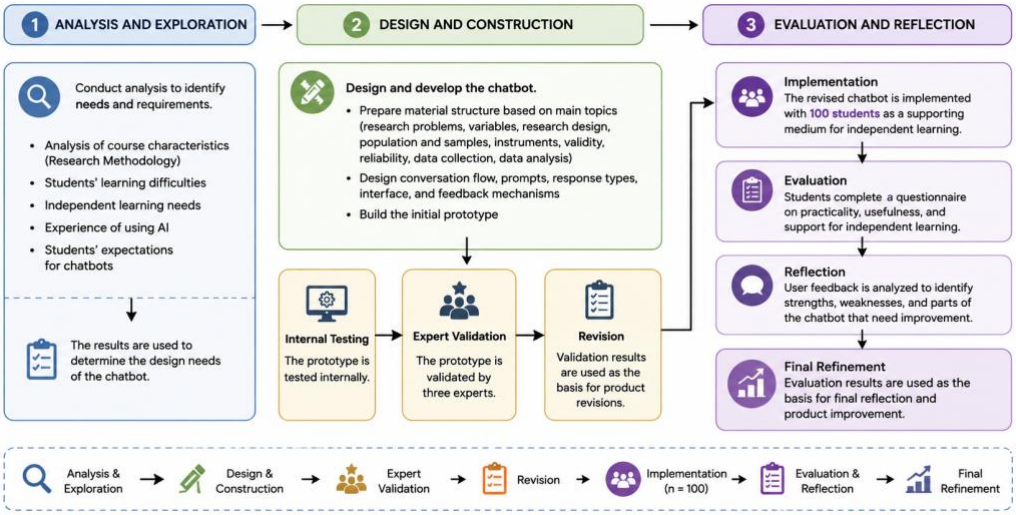


Figure 2. Research Prosedure

In the Analysis and Exploration stage, the researcher analyzed the Research Methodology course, students' learning difficulties, independent learning needs, prior experience with AI, and expectations for using an AI-based chatbot. The findings from this stage informed the functional, pedagogical, and content requirements for chatbot development.

In the Design and Construction stage, the team developed the chatbot prototype based on the identified requirements. This stage included designing the content structure, conversation flow, prompts, response types, user interface, and feedback mechanisms. The chatbot content covered major topics in the Research Methodology course, including research problems, variables, research designs, populations and samples, research instruments, validity and reliability, data collection, and data analysis. The initial prototype was subsequently subjected to internal testing and validated by three experts. The expert validation results were used to revise and refine the chatbot prior to implementation. Particular attention was given to the quality of chatbot interaction because interaction design is an important component of effective educational chatbot development (Kuhail et al., 2023).

In the Evaluation and Reflection stage, the revised chatbot was implemented with 100 students as a supporting tool for independent learning. After using the chatbot, students completed a questionnaire assessing its practicality, usefulness, and support for independent learning. Their responses and feedback were analyzed to identify the strengths and limitations of the chatbot and areas requiring further improvement. The evaluation findings were then used as the basis for final reflection and product refinement.Data Analysis

Quantitative data is analyzed using frequency, percentage, average, and standard deviation. Content validity was assessed using Aiken's V, while instrument reliability was tested with Cronbach's alpha. Student evaluation scores are converted into percentages with categories: 81–100% very feasible/very practical, 61–80% feasible/practical, 41–60% moderately feasible/moderately practical, 21–40% less feasible/less practical, and 0–20% not feasible/impractical.

The difference in scores between centers is analyzed using one-way ANOVA if the data meets the parametric assumptions. If the assumption is not met, the Kruskal-Wallis test is used. The significance level was set at $p < 0.05$. Open-ended responses from experts and students were analyzed descriptively through thematic groupings that included materials, pedagogy, language, technology, and usability. Quantitative and qualitative results are used together to evaluate and improve the chatbot.

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

3. Results and Discussion

3.1. Analysis and Exploration Results

The Analysis and Exploration phase identified students' needs for independent learning support in the distance education system. The analysis focused on learning difficulties experienced during independent study, the types of academic assistance students expected, previous experience with AI-based applications, and their interest in using an AI chatbot as a learning companion. The results showed that students generally needed learning support that was accessible, responsive, flexible, and able to provide explanations and examples based on individual learning needs (see Table 1).

Table 1. Results of Student Needs Analysis

Aspect of Needs Analysis	Students (%)
Difficulty obtaining immediate clarification when learning independently	82
Difficulty maintaining understanding without direct lecturer assistance	76
Need for contextual examples to support understanding	85
Need for step-by-step learning guidance	80
Need for immediate feedback during independent learning	83
Need for learning support that can be accessed flexibly	87
Previous experience using AI for academic purposes	76
Interest in using an AI chatbot as learning support	88

Table 1 shows that the strongest needs were related to flexible access, contextual examples, immediate feedback, and rapid clarification during independent learning. Students also demonstrated a high level of interest in using an AI chatbot as learning support, while most had already experienced AI-based applications in academic activities. These findings indicate that students were relatively prepared to engage with AI-assisted learning but required a more structured and pedagogically directed system.

Based on these results, five main design requirements were identified for the chatbot: flexible access, immediate response, contextual explanations, step-by-step guidance, and feedback that supports students' independent learning processes. These requirements became the basis for determining the chatbot's interaction structure, response format, learning-support features, and user experience in the subsequent Design and Construction phase.

3.2. Design and Construction of the AI-Based Chatbot

The Design and Construction phase translated the results of the needs analysis into the structure and main functions of the AI-based chatbot. The chatbot was designed as a flexible learning companion that could be accessed independently, provide immediate responses, present contextual explanations, guide students through difficult concepts step by step, and offer feedback according to individual learning needs (see Figure 3). The design also emphasized simplicity of interaction so that students could use the chatbot without requiring complex technical procedures.

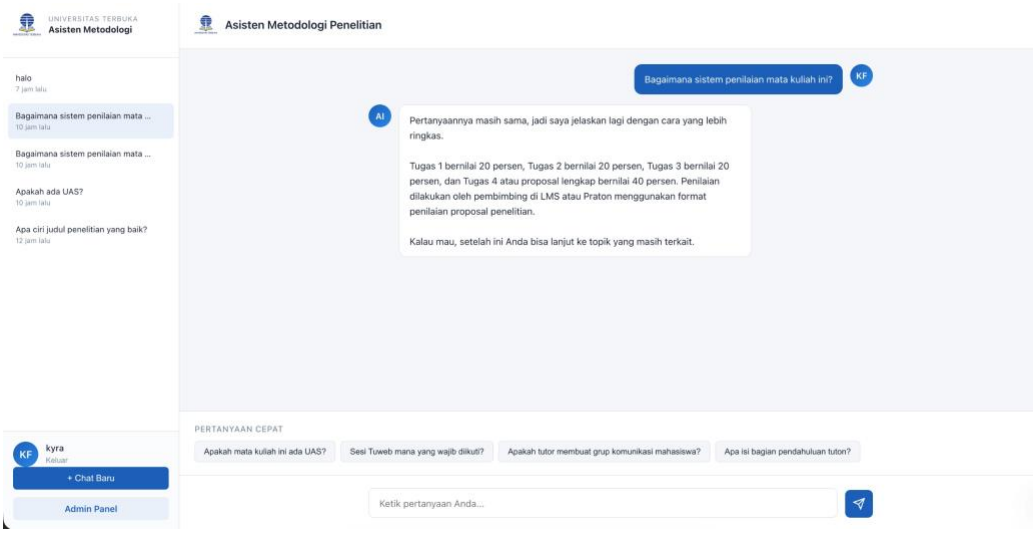


Figure 3. AI-Based Chatbot Link: https://edumindut.com/

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

The developed chatbot consisted of several main features, including conceptual explanation, contextual examples, guided questions, clarification support, immediate feedback, and flexible access. Each feature was designed to address the needs identified in the previous phase. Table 2 shows that the chatbot was not designed merely as an automated question-answering system, but as a structured learning support tool. The combination of explanation, examples, guiding questions, clarification, and immediate feedback was intended to create a more interactive learning experience while still maintaining students' active role in the learning process.

Table 2. Main Features of the AI-Based Chatbot

Feature	Main Function
Concept Explanation	Provides concise explanations according to students' questions
Contextual Examples	Presents examples that help students connect concepts with practical situations
Guided Questions	Encourages students to think through problems before receiving further explanation
Clarification Support	Helps students revisit concepts that are not yet fully understood
Immediate Feedback	Provides direct responses to student input during independent learning
Flexible Access	Enables students to use the chatbot according to their own learning time and pace

The final prototype was organized around a simple interaction flow in which students entered questions or learning difficulties, received an initial response from the chatbot, and could then continue the interaction through clarification requests, additional examples, or guided follow-up questions. This structure was expected to support more flexible and personalized independent learning before the product proceeded to the expert validation stage.

3.3. Expert Validation Results

The developed AI-based chatbot was evaluated by three experts representing content, instructional technology, and AI-supported learning. The validation focused on six main aspects: content accuracy, pedagogical appropriateness, language clarity, interaction design, technological functionality, and support for independent learning. The results showed that all evaluated aspects met the required validity criteria. Table 3 shows that the overall Aiken's V coefficient reached 0.90, indicating a high level of expert agreement regarding the quality and appropriateness of the developed chatbot. Technological functionality obtained the highest value, while interaction design received the lowest value, although it remained within the high category. These results indicate that the chatbot was considered suitable for further implementation after minor revisions.

Table 3. Expert Validation Results of the AI-Based Chatbot

Validation Aspect	Aiken's V	Category
Content accuracy	0.92	High
Pedagogical appropriateness	0.88	High
Language clarity	0.90	High
Interaction design	0.83	High
Technological functionality	0.96	Very High
Independent learning support	0.91	High
Overall	0.90	High

The experts mainly recommended improvements in the consistency of chatbot responses, simplification of several instructions, refinement of conversational prompts, and clearer guidance for responsible AI use. These suggestions were incorporated into the revised prototype before the student field evaluation.

3.4. Practicality and Usability Results

The practicality and usability evaluation was conducted after the AI-based chatbot had been implemented with 100 students across the four regional learning centers. The evaluation focused on ease of access, ease of use, response clarity, response relevance, system responsiveness, and learning flexibility. Overall, students provided positive evaluations across all aspects, as illustrated in Figure 4.

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

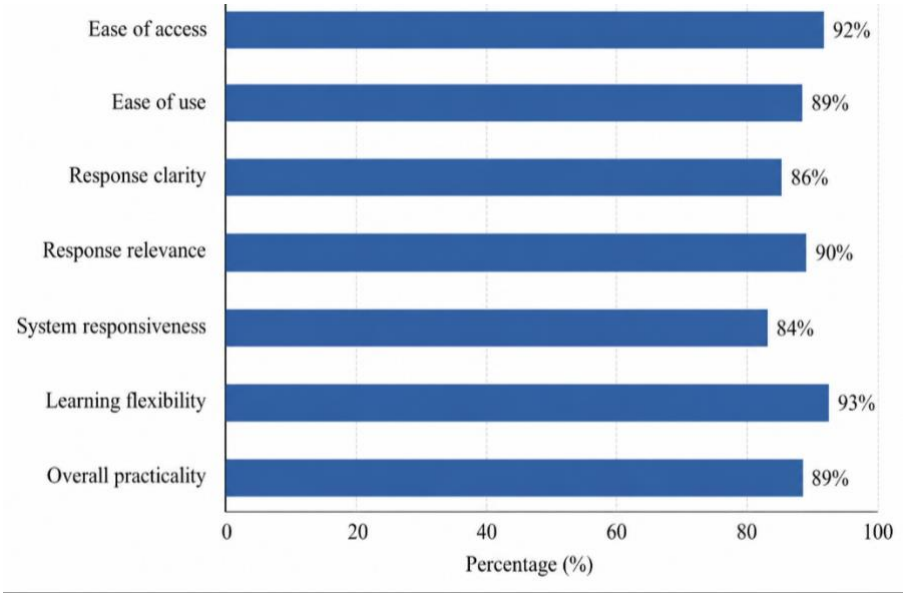


Figure 4. Students' Practicality and Usability Ratings of the AI-Based Chatbot

Figure 4 shows that students perceive AI-based chatbots as highly practical and useful. The highest score is in learning flexibility, showing that students see the main benefit of chatbots as providing learning support they can access on their own time and to their needs. Ease of access and response relevance also received high ratings, indicating that chatbots provide a simple user experience while meeting students' learning needs. Although the system's responsiveness received the lowest score compared to other aspects, it remained in the very practical category. Overall, these results show that chatbots can function as an easy-to-use, flexible, and relevant learning support medium in the context of distance education.

3.5. Results Across Regional Learning Centers

The Reflection and Product Refinement stage integrated feedback from expert validators, functional testing, and student responses during field implementation. This stage aimed to identify aspects of the chatbot that still required improvement before establishing the final prototype. Table 5 summarizes the feedback and corresponding product refinements.

Table 5. Student Evaluation Across Regional Learning Centers

UPBJJ	N	Practicality and Usability Mean	Independent Learning Support Mean
Bandung	25	4.47	4.43
Purwokerto	25	4.41	4.38
Bogor	25	4.45	4.40
Yogyakarta	25	4.49	4.46
Overall	100	4.46	4.42

Table 5 shows relatively similar evaluation patterns across the four UPBJJ locations. Yogyakarta obtained the highest mean scores for both practicality and independent learning support, while Purwokerto recorded slightly lower scores. However, the differences among the regional groups were relatively small, indicating that the chatbot provided a generally consistent user experience across geographically separated learning environments.

Further analysis using one-way ANOVA showed no statistically significant differences among the four UPBJJ groups in practicality and usability scores ($p > .05$) or in independent learning support scores ($p > .05$). These results suggest that the developed AI-based chatbot could be accessed and used with relatively consistent quality across the four regional contexts, supporting its potential use within a broader distance education environment.

3.6. Reflection and Product Refinement

The Reflection and Product Refinement stage integrated feedback from expert validators, functional testing, and student responses during field implementation. This stage aimed to identify aspects of the chatbot that still required improvement before establishing the final prototype. Table 6 shows that the main refinements were directed toward improving clarity, interaction quality, and pedagogical control. The chatbot was adjusted so that responses became more concise, contextual, and easier to follow. The refinement of prompts also

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

reduced the tendency of the system to provide direct answers and strengthened its role as a learning companion that encourages students to think, clarify, and make decisions independently. The reflection process resulted in a final prototype characterized by simpler navigation, more structured responses, stronger contextual support, clearer feedback, and more explicit guidance for responsible AI use. These refinements indicate that the final chatbot was not merely technically functional but had also been improved based on actual user experience and expert evaluation before being considered ready for broader use in distance learning contexts.

Table 6. Product Refinement Based on Evaluation Results

Identified Issue	Product Refinement
Some chatbot responses were too long	Responses were shortened and reorganized into clearer sections
Several instructions were considered less concise	Instructions were simplified and made more direct
Students needed more contextual examples	Additional examples were integrated into the chatbot responses
Some prompts tended to generate direct answers	Guiding prompts were revised to encourage students' thinking process
Navigation labels were not sufficiently clear	Menu labels and interaction instructions were simplified
Students required clearer guidance on responsible AI use	Verification reminders and responsible-use guidance were added

The findings of this study indicate that the development of an AI-based chatbot in distance education responds to a learning problem that is fundamentally related to access to timely academic support. Students did not simply require more digital learning materials; they required assistance that could be accessed when difficulties emerged during independent study. The needs-analysis results showed strong demand for flexible access, contextual examples, immediate feedback, and step-by-step guidance. This pattern is meaningful because distance learners often manage learning activities outside fixed classroom schedules, making the timing of support almost as important as the content of the support itself. Correia et al. (2024) argue that meaningful AI integration in online learning requires learner-centered design in which technology is embedded into the actual conditions under which students study rather than added as an isolated digital feature. Labadze et al. (2023) similarly found that one of the most consistent advantages of educational chatbots is their capacity to provide study assistance, explanations, personalized support, and flexible access to learning resources. The high interest in chatbot use found in the present study should therefore be interpreted beyond technological enthusiasm. Most participating students had already encountered AI in academic activities, suggesting that the question was no longer whether they were willing to interact with AI, but whether that interaction could be organized in a manner that genuinely supported learning. Stöhr et al. (2024) found that AI chatbots were already widely encountered by university students, although attitudes toward their educational use were accompanied by concerns regarding reliability and responsible use. This helps explain why the chatbot developed in the present study was deliberately structured around clarification, examples, guiding questions, and feedback. Familiarity with AI does not automatically mean that students know how to use it productively. What students appear to need is a learning environment that transforms easy access to AI into purposeful academic interaction.

This interpretation becomes more important when the findings are viewed through the lens of independent learning. Independent learning does not mean that students should be left alone with learning materials. Rather, independence becomes possible when learners have sufficient resources to recognize difficulties, seek appropriate assistance, monitor understanding, and decide what to do next. Guan et al. (2025) found that educational chatbots can support several important components of self-regulated learning, particularly identifying learning resources, implementing learning strategies, and monitoring learning progress. Their review also showed, however, that existing chatbots provide comparatively less support for goal setting, planning, reflection, and adaptation of subsequent learning strategies. The present findings therefore reinforce the importance of designing chatbot interaction as a scaffold rather than simply as an information-retrieval mechanism.

The design developed in this study reflects this principle. The chatbot combines conceptual explanations, contextual examples, clarification support, guiding questions, immediate feedback, and flexible access. These features create a conversational pathway in which a student can begin with uncertainty and progressively move toward greater understanding. This seemingly simple process has considerable pedagogical significance. A student studying independently may encounter a concept late at night, reread the available material, remain uncertain, and postpone the learning task because no lecturer is immediately available. A responsive chatbot changes that learning moment by allowing the student to ask, clarify, request another example, or reconsider an explanation without waiting for the next synchronous interaction. Lee et al. (2025) demonstrated that chatbot-assisted self-regulated learning providing personalized and immediate feedback improved university students' performance, motivation, reflection, metacognitive tendencies, and self-regulation compared with conventional self-regulated learning support. Thus, immediacy in this context is pedagogically meaningful because it may prevent temporary confusion from becoming prolonged disengagement.

Nevertheless, the findings should not be interpreted to mean that immediate AI responses automatically create independent learners. This distinction is important. Guan et al. (2025) found mixed and non-significant

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

effects in some chatbot interventions despite generally positive evidence. McGrath et al. (2025) also observed that empirical research on generative AI chatbots in higher education remains conceptually fragmented and often oscillates between optimistic and pessimistic accounts of technology. These findings caution against equating availability with learning quality. A chatbot may answer quickly, yet a rapid answer that removes the need to reason could weaken rather than strengthen independent learning. The educational value of the chatbot developed in this study therefore lies less in how quickly it produces answers and more in how its responses position students in relation to their own thinking.

The expert-validation results strengthen this interpretation. An overall Aiken's V of 0.90 indicates strong agreement regarding the appropriateness of the developed product, while technological functionality received the strongest evaluation. This result is understandable because accessibility, response generation, and interaction stability constitute the visible infrastructure through which students experience the chatbot. Yet interaction design received a comparatively lower score, despite remaining within the high category. Rather than being viewed as a weakness, this difference reveals an important characteristic of educational AI development: technological functionality is often easier to establish than pedagogically meaningful conversation.

A chatbot may function technically without necessarily functioning well educationally. McGrath et al. (2025) noted that a major weakness in emerging higher-education chatbot research is the limited use of coherent theories of human learning to explain how chatbot interaction supports educational processes. Labadze et al. (2023) likewise emphasized that benefits such as personalized learning and study assistance coexist with concerns about reliability, accuracy, and ethics. The expert recommendations in the present study particularly shortening responses, strengthening guiding prompts, and clarifying responsible AI use therefore address a deeper issue than interface refinement. They represent efforts to regulate the relationship between AI assistance and student agency.

The practicality and usability findings provide another important layer of evidence. The overall score of 89% indicates that students were generally able to use the chatbot comfortably within the distance-learning environment. Learning flexibility obtained the highest evaluation, followed by ease of access and response relevance. This pattern is especially meaningful in PJJ because flexibility is not merely a convenience. It is part of the architecture of learning itself. Students may learn at different times, from different locations, and under different personal circumstances. A learning tool that requires students to conform to rigid access patterns would reproduce one of the problems that distance education is intended to overcome.

Correia et al. (2024) emphasize that AI-supported online learning should be designed around the learner's experience while still considering ethical and social dimensions of generative AI. Fageeh (2025) similarly found that the ways students engage with chatbots in higher education are shaped by their motivations, user profiles, and integration strategies rather than by technological availability alone. The high flexibility score in the present study can therefore be understood as evidence that the chatbot corresponded reasonably well with the temporal and spatial characteristics of PJJ. Students could determine when assistance was needed instead of adjusting their difficulties to the availability of assistance.

System responsiveness obtained the lowest score among the practicality indicators, although it remained within the very practical category. This apparently minor finding deserves attention because responsiveness is part of the user's sense of continuity during digital interaction. A student who expects conversational immediacy may perceive even a short technical delay differently from a student reading a static learning module. The result suggests that future refinement should consider not only response accuracy but also response speed, stability, and the perceived smoothness of interaction. Such technical factors become pedagogically relevant when interruptions break concentration or discourage students from continuing an inquiry.

The regional findings provide further evidence that the chatbot's practicality was not restricted to one learning center. Scores from Bandung, Purwokerto, Bogor, and Yogyakarta were relatively close, and the supplementary analysis indicated no statistically significant regional differences. The most important interpretation is not that all students had identical experiences, but that geographical location did not appear to create a substantial difference in overall chatbot evaluation within this sample. This is encouraging for distance education because a digital intervention should ideally provide reasonably consistent learning support across locations. At the same time, regional consistency should be interpreted cautiously. Similar averages do not mean that all contextual differences have disappeared. Device quality, internet connectivity, digital literacy, prior AI experience, employment responsibilities, and study habits may still shape individual experiences. Stöhr et al. (2024) showed that patterns of AI-chatbot use in higher education vary across student characteristics and educational contexts. Correia et al. (2024) also emphasize that online AI integration involves social and contextual considerations alongside technological design. Consequently, the absence of strong regional differences in the present study should be understood as preliminary evidence of cross-context usability, rather than proof that contextual conditions are irrelevant.

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

A particularly important contribution of this study emerges from the product-refinement stage. Expert and student feedback led to shorter responses, clearer navigation, additional contextual examples, stronger guiding questions, and explicit reminders regarding responsible AI use. This iterative process reflects a view of educational technology in which imperfections encountered by users are treated as design information rather than simply as failures. The chatbot became more educationally useful because it was revised in response to how people actually experienced it.

The inclusion of guiding questions is especially significant. Generative AI carries a genuine risk of shifting students from active engagement toward convenient answer consumption. Abbas et al. (2024) found that excessive ChatGPT use among university students was associated with procrastination, memory loss, and poorer academic performance, particularly when AI use functioned as a shortcut under conditions of workload and time pressure. These findings contrast with studies reporting positive learning effects, but the apparent contradiction is instructive. AI may be helpful when it extends students' thinking and harmful when it replaces the cognitive work that learning requires. Evidence from Pallant et al. (2025) supports this distinction. Their findings suggest that higher-level learning occurs when students use generative AI to construct and augment knowledge, whereas more procedural use characterized by reproducing AI output is associated with lower-level learning. This provides an important rationale for the design choices made in the present study. The chatbot was progressively refined so that it did not simply become a faster route to a finished answer. Guiding prompts, clarification, contextual examples, and verification reminders were intended to create small moments in which students still had to interpret, choose, question, and reflect.

The main contribution of the study is not simply the production of another AI chatbot. General-purpose AI chatbots are already readily available to university students. The contribution lies in demonstrating how a conversational AI tool can be pedagogically bounded around the conditions of independent learning in a distance education system. Labadze et al. (2023) demonstrate that AI chatbots can personalize learning and provide study assistance, while Guan et al. (2025) show their potential to scaffold self-regulated learning processes. At the same time, McGrath et al. (2025) and Abbas et al. (2024) remind us that educational value cannot be assumed merely because AI is present. The findings of the present study bring these two positions together. The resulting synthesis is that an AI chatbot becomes educationally meaningful in PJJ when accessibility, responsiveness, pedagogical scaffolding, and learner agency operate together. Accessibility allows support to reach students wherever and whenever they study. Responsiveness prevents learning difficulties from remaining unresolved for too long. Pedagogical scaffolding transforms AI responses from answers into learning assistance. Learner agency ensures that the student remains the person who interprets information, evaluates alternatives, and ultimately makes learning decisions. Removing any one of these elements changes the character of the intervention: accessible AI without scaffolding may encourage dependence; pedagogical prompts without reliable access may fail to meet the realities of distance learners; and technically sophisticated AI without learner agency risks turning independent learning into automated task completion.

The findings suggest a shift in how AI should be conceptualized within distance education. AI is most valuable not when it attempts to replace lecturer presence, but when it fills the small gaps in support that naturally occur between formal learning interactions. A student does not always need another lecture; sometimes the student needs one explanation stated differently, one contextual example, one question that redirects thinking, or timely reassurance that the learning path being followed makes sense. In this role, the chatbot functions as a pedagogical bridge between institutional learning resources and the moment-to-moment realities of independent study. This represents the central contribution of the developed product and provides a foundation for broader investigation of AI-supported independent learning in distance higher education.

3.7. Implications

The findings of this study imply that AI-based chatbots can serve as a meaningful support mechanism for independent learning in distance education when their design combines accessibility, responsiveness, pedagogical guidance, and learner control. Practically, institutions can integrate course-specific chatbots as supplementary learning support that provides clarification, contextual examples, immediate feedback, and flexible assistance outside scheduled lecturer interaction. Pedagogically, the chatbot should function as a scaffold that stimulates students' reasoning rather than as an automatic answer generator, thereby preserving learner agency and reducing the risk of overdependence on AI. Institutionally, the results also suggest the need for clear guidance on responsible AI use, attention to system reliability, and continuous evaluation of chatbot responses and user experience. More broadly, the relatively consistent responses across regional learning centers indicate that such technology has potential to strengthen equitable access to academic support in geographically distributed distance-learning environments.

3.8. Limitations

This study has several limitations that should be considered when interpreting the findings. First, the evaluation involved only 100 undergraduate students from four regional learning centers, so the findings cannot yet be generalized to all distance-education students with different academic, technological, and socioeconomic

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

characteristics. Second, the study primarily measured feasibility, practicality, usability, and perceived support for independent learning rather than long-term learning outcomes, retention, or changes in students' actual self-regulated learning behavior. Third, the quality of chatbot interaction may also be influenced by internet connectivity, device performance, students' prior experience with AI, and the accuracy of AI-generated responses, which were not examined as independent variables. Finally, the study was conducted within a limited implementation period; therefore, further research should involve broader samples, longer-term use, comparative designs, and direct measurement of learning outcomes to provide stronger evidence of the chatbot's educational effectiveness.

4. Conclusion

This study developed an Artificial Intelligence (AI)-based chatbot to support independent learning in a distance education system through an Educational Design Research approach. The findings indicate that the chatbot was developed from authentic learner needs, particularly the need for flexible access, immediate clarification, contextual examples, step-by-step guidance, and responsive feedback. Expert validation showed that the product achieved a high level of validity, while student evaluations demonstrated high practicality, usability, and perceived support for independent learning across the four regional learning centers. The relatively consistent responses among students from Bandung, Purwokerto, Bogor, and Yogyakarta further suggest that the chatbot has potential to provide learning support across geographically dispersed contexts. The main contribution of this study lies in positioning AI not as an automatic answer provider, but as a structured pedagogical support that helps students clarify difficulties, access assistance when needed, and remain actively involved in their own learning process. These findings imply that AI-based chatbots can become a relevant complementary component of distance education when technological accessibility is integrated with pedagogical scaffolding, responsible AI use, and learner agency. Further development should examine broader populations, longer implementation periods, learning outcomes, and the long-term effects of chatbot use on students' independent and self-regulated learning.

Author Contributions

Suryo Prabowo: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Visualization, Writing original draft. Abd Ghofur: Methodology, Validation, Formal analysis, Resources, Writing review & editing. Andayani: Conceptualization, Methodology, Supervision, Validation, Project administration, Writing review & editing. Bramianto Setiawan: Supervision, Project administration, Writing – review & editing.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability

The datasets generated during and/ or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration on AI Use

The authors declare that AI-assisted technologies were used solely to improve the readability and language of the manuscript under strict human oversight. No scientific content, ideas, analyses, interpretations, conclusions, or recommendations were generated by AI. The authors reviewed and edited all AI-assisted outputs and take full responsibility for the content of the manuscript.

References

Abbas, M., Jam, F. A., & Khan, T. I. (2024). Is it harmful or helpful? Examining the causes and consequences of generative AI usage among university students. *International Journal of Educational Technology in Higher Education, 21*, Article 10. https://doi.org/10.1186/s41239-024-00444-7

Ali, F., Choy, D., Divaharan, S., Tay, H. Y., & Chen, W. (2023). Supporting self-directed learning and self-assessment using TeacherGAIA, a generative AI chatbot application: Learning approaches and prompt engineering. *Learning: Research and Practice, 9*(2), 135–147. https://doi.org/10.1080/23735082.2023.2258886

Bond, M., Khosravi, H., De Laat, M., Bergdahl, N., Negrea, V., Oxley, E., Pham, P., Chong, S. W., & Siemens, G. (2024). A meta systematic review of artificial intelligence in higher education: A call for increased ethics, collaboration, and rigour. *International Journal of Educational Technology in Higher Education, 21*, Article 4. https://doi.org/10.1186/s41239-023-00436-z

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

Cela-Ranilla, J., Esteve-Mon, F. M., & Sánchez-Caballé, A. (2025). Design-based research in higher education: A systematic literature review between 2019 and 2023. *Australasian Journal of Educational Technology, 41*(4), 67–83. https://doi.org/10.14742/ajet.10380

Chan, C. K. Y., & Hu, W. (2023). Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education, 20*, Article 43. https://doi.org/10.1186/s41239-023-00411-8

Ch'ng, L. K. (2023). How AI makes its mark on instructional design. *Asian Journal of Distance Education, 18*(2), 32–41. https://doi.org/10.5281/zenodo.8161556

Correia, A.-P., Hickey, M. S., & Xu, F. (2024). Beyond the virtual classroom: Integrating artificial intelligence in online learning. *Distance Education, 45*(3), 481–491. https://doi.org/10.1080/01587919.2024.2338706

Debets, T., Banihashem, S. K., Joosten-Ten Brinke, D., Vos, T. E. J., Maillette de Buy Wenniger, G., & Camp, G. (2025). Chatbots in education: A systematic review of objectives, underlying technology and theory, evaluation criteria, and impacts. *Computers & Education, 234*, Article 105323. https://doi.org/10.1016/j.compedu.2025.105323

Fageeh, A. (2025). The rise of chatbots in higher education: Exploring user profiles, motivations, and integration strategies. *Social Sciences & Humanities Open, 12*, Article 101996. https://doi.org/10.1016/j.ssaho.2025.101996

González-Pérez, L. I., Enciso-González, J. A., Vicario-Solorzano, C. M., & Ramírez-Montoya, M. S. (2025). Measuring digital transformation in Education 4.0 with DT-Smarty: Valid and reliable model. *Technology, Knowledge and Learning*. Advance online publication. https://doi.org/10.1007/s10758-025-09844-8

Guan, R., Raković, M., Chen, G., & Gašević, D. (2025). How educational chatbots support self-regulated learning? A systematic review of the literature. *Education and Information Technologies, 30*, 4493–4518. https://doi.org/10.1007/s10639-024-12881-y

Habibi, A., Muhaimin, Danibao, B. K., Wibowo, Y. G., Wahyuni, S., & Octavia, A. (2023). ChatGPT in higher education learning: Acceptance and use. *Computers and Education: Artificial Intelligence, 5*, Article 100190. https://doi.org/10.1016/j.caeai.2023.100190

Jo, H. (2024). From concerns to benefits: A comprehensive study of ChatGPT usage in education. *International Journal of Educational Technology in Higher Education, 21*, Article 35. https://doi.org/10.1186/s41239-024-00471-4

Kuhail, M. A., Alturki, N., Alramlawi, S., & Alhejori, K. (2023). Interacting with educational chatbots: A systematic review. *Education and Information Technologies, 28*(1), 973–1018. https://doi.org/10.1007/s10639-022-11177-3

Labadze, L., Grigolia, M., & Machaidze, L. (2023). Role of AI chatbots in education: Systematic literature review. *International Journal of Educational Technology in Higher Education, 20*, Article 56. https://doi.org/10.1186/s41239-023-00426-1

Lee, Y.-F., Hwang, G.-J., & Chen, P.-Y. (2022). Impacts of an AI-based chatbot on college students' after-class review, academic performance, self-efficacy, learning attitude, and motivation. *Educational Technology Research and Development, 70*, 1843–1865. https://doi.org/10.1007/s11423-022-10142-8

Lee, Y.-F., Hwang, G.-J., & Chen, P.-Y. (2025). Technology-based interactive guidance to promote learning performance and self-regulation: A chatbot-assisted self-regulated learning approach. *Educational Technology Research and Development, 73*, 2279–2304. https://doi.org/10.1007/s11423-025-10478-x

Lin, M. P.-C., Chang, D. H., & Winne, P. H. (2025). A proposed methodology for investigating student-chatbot interaction patterns in giving peer feedback. *Educational Technology Research and Development, 73*, 353–386. https://doi.org/10.1007/s11423-024-10408-3

Luo, J., Zheng, C., Yin, J., & Teo, H. H. (2025). Design and assessment of AI-based learning tools in higher education: A systematic review. *International Journal of Educational Technology in Higher Education, 22*, Article 42. https://doi.org/10.1186/s41239-025-00540-2

Malik, A. R., Pratiwi, Y., Andajani, K., Numertayasa, I. W., Suharti, S., Darwis, A., & Marzuki. (2023). Exploring artificial intelligence in academic essay: Higher education student's perspective. *International Journal of Educational Research Open, 5*, Article 100296. https://doi.org/10.1016/j.ijedro.2023.100296

McGrath, C., Farazouli, A., & Cerratto-Pargman, T. (2025). Generative AI chatbots in higher education: A review of an emerging research area. *Higher Education, 89*, 1533–1549. https://doi.org/10.1007/s10734-024-01288-w

Nagy, A. S., Tumiwa, J. R., Arie, F. V., & Erdey, L. (2024). An exploratory study of artificial intelligence adoption in higher education. *Cogent Education, 11*(1), Article 2386892. https://doi.org/10.1080/2331186X.2024.2386892

Pallant, J. L., Blijlevens, J., Campbell, A., & Jopp, R. (2026). Mastering knowledge: The impact of generative AI on student learning outcomes. *Studies in Higher Education, 51*(4), 714–735. https://doi.org/10.1080/03075079.2025.2487570

Palomero-Fernández, P., & Vicente-Sánchez, E. (2025). Assessing the willingness of Spanish pre-service secondary school teachers to use group dynamics techniques: Design and validation of an instrument. *Journal of New Approaches in Educational Research, 14*, Article 16. https://doi.org/10.1007/s44322-025-00037-w

Sabaruddin, Nur, M., Fadli, M., & Mazlan. (2022). Content validity of KIP-K scholarship instruments at higher education using Aiken's coefficient validity scale. *Al-Tanzim: Jurnal Manajemen Pendidikan Islam, 6*(3). https://doi.org/10.33650/al-tanzim.v6i3.3680

Stöhr, C., Ou, A. W., & Malmström, H. (2024). Perceptions and usage of AI chatbots among students in higher education across genders, academic levels and fields of study. *Computers and Education: Artificial Intelligence, 7*, Article 100259. https://doi.org/10.1016/j.caeai.2024.100259

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174

Sustaningrum, R., & Haldaka, M. (2025). Student utilization and perceptions of AI technology for academic purposes: A mixed-method analysis. *Cogent Education, 12*(1), Article 2553835. https://doi.org/10.1080/2331186X.2025.2553835

Weng, X., Xia, Q., Gu, M., Rajaram, K., & Chiu, T. K. F. (2024). Assessment and learning outcomes for generative AI in higher education: A scoping review on current research status and trends. *Australasian Journal of Educational Technology, 40*(6), 37–55. https://doi.org/10.14742/ajet.9540

© 2026 The Author(s)
This is an Open Access article under the Creative Commons Attribution-ShareAlike 4.0 International License
ISSN: 2797-3174