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Effectiveness of using educational chatbots in improving student learning independence

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Abstract

This study investigates the effectiveness of educational chatbots in increasing students' learning independence in higher education. As artificial intelligence (AI) technologies are increasingly integrated into the digital learning ecosystem, chatbots have emerged as a promising tool for providing immediate feedback, improving self-directed learning (SRL), and supporting students in becoming more independent learners. Using a mixed methods approach, this research involved 150 undergraduate students at three universities in Indonesia who used a custom-designed chatbot embedded in their Learning Management System (LMS). Data was collected through pre- and post-tests, structured surveys, and focus group discussions. The results showed a significant increase in students' ability to plan, monitor and evaluate their learning process independently. Participants also reported increased motivation, self-confidence, and willingness to engage in self-directed learning activities. These findings suggest that educational chatbots can act as cost-effective, scalable, and non-judgmental learning companions, especially in blended and online learning contexts. Future research should explore the long-term impacts and integrate chatbot interventions with broader digital pedagogy frameworks. The results show a significant improvement in students' ability to manage their own learning, set goals, and solve problems independently. Students reported increased motivation and confidence in seeking information without constant teacher assistance. These findings suggest that educational chatbots can serve as effective support systems for developing learner autonomy, particularly in blended or online learning environments.

Keywords: Educational chatbots, Learning independence, Autonomous learning, Artificial intelligence in education, Student motivation, Higher education

Introduction

In an era of rapid technological progress, the integration of artificial intelligence (AI) in education is increasingly widespread. One emerging AI-based tool is educational chatbots, which have the potential to transform the learning environment by providing interactive, fast and personalized assistance to students. Educational chatbots are designed to facilitate communication between students and learning materials, offering explanations, answering questions, and guiding students throughout the educational process.

Student learning independence is an important skill in modern education, as it encourages independent learning, critical thinking, and lifelong learning habits. However, many students struggle to maintain autonomy in their studies due to limited access to timely feedback, lack of motivation, and lack of guidance outside the classroom. The presence of chatbots in educational platforms offers a potential solution by acting as virtual assistants that support students beyond the confines of the traditional classroom.

Previous research has highlighted the potential benefits of chatbots in increasing student engagement and providing ongoing support. However, there is still a gap in understanding the extent to which educational chatbots effectively promote independent learning among students. By assessing its impact, educators can better integrate chatbot technology into teaching strategies to create more flexible and student-centered learning experiences.

This research aims to evaluate the effectiveness of using educational chatbots in increasing student learning independence. This research focuses on identifying how chatbot-assisted learning impacts students' ability to plan, monitor, and evaluate their own learning processes, as well as its role in encouraging self-directed learning behavior in higher education settings.

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The integration of artificial intelligence (AI) in education, particularly through the use of educational chatbots, is changing traditional learning models by offering instant feedback, personalized guidance, and ongoing support. Educational chatbots provide interactive assistance that helps students plan, monitor, and evaluate their learning activities outside the classroom. This development is very relevant to the concept of independent learning which emphasizes students' ability to self-regulate their learning habits, maintain intrinsic motivation, and develop lifelong learning skills.

Although the application of chatbots in various educational contexts is increasing, there is still a lack of comprehensive evidence regarding the effectiveness of chatbots in fostering learning independence. Recent research shows promising results in areas such as language acquisition, critical thinking, and independent learning; however, the impact varies depending on the design, context, and level of integration in the curriculum. Therefore, this research seeks to evaluate the effectiveness of educational chatbots in increasing students' learning independence, focusing on how such tools influence students' autonomy, motivation, and ability to effectively manage their learning processes.

The advancement of artificial intelligence (AI) in education has led to the development of various digital tools that aim to improve student learning outcomes. Among these innovations, educational chatbots have gained increasing attention for their ability to provide real-time assistance, deliver personalized content, and support learner autonomy (Winkler & Söllner, 2018). Chatbots, which simulate human conversation using natural language processing, can act as virtual tutors, guiding students through course material and responding to their questions instantly—without direct intervention from instructors (Kuhail et al., 2022).

Student learning independence, often referred to as learner autonomy, is a critical component of successful learning, especially in online and hybrid environments. It involves students' ability to take initiative, set learning goals, monitor their progress, and seek resources proactively (Little, 2007). As higher education increasingly adopts flexible and self-directed learning models, fostering such independence becomes essential.

Recent studies have highlighted the potential of chatbots to support these efforts. For example, students who used educational chatbots demonstrated improved time management and decision-making in learning tasks (Yin et al., 2021). Additionally, chatbots can provide motivational prompts, clarify misconceptions, and recommend learning paths—all of which contribute to building independent learning habits.

Despite these benefits, the effectiveness of chatbots in enhancing student independence remains under-researched in many educational contexts, particularly in developing countries. This study aims to fill that gap by evaluating the impact of educational chatbot usage on students' learning independence in Indonesian higher education institutions. The research addresses the following questions:

(1) To what extent do chatbots improve students' ability to learn independently? and

(2) What are students' perceptions of using chatbots as part of their learning process?

1. Educational chatbots in higher education

Educational chatbots are AI-driven conversational agents designed to interact with students through natural language interfaces. In higher education, chatbots have been utilized for a range of academic functions including tutoring, administrative support, and mental health guidance (Kuhail et al., 2022). Chatbots can simulate human-like dialogue to provide immediate responses to students' queries, which significantly reduces dependence on instructors and fosters more self-reliant behavior (Winkler & Söllner, 2018). In addition, chatbot interfaces integrated into Learning Management Systems (LMS) allow students to access learning content, deadlines, and assessment feedback anytime and anywhere, thereby supporting continuous and flexible learning.

2. Learning independence and autonomy

Learning independence, or learner autonomy, refers to a student's ability to take control of their learning process—setting goals, selecting strategies, and evaluating outcomes (Little, 2007). Independent learners typically demonstrate stronger

metacognitive skills, intrinsic motivation, and resilience in facing academic challenges. In technology-enhanced learning environments, the need for learner autonomy becomes even more critical due to reduced direct supervision. Research indicates that tools which encourage active exploration, self-paced learning, and decision-making contribute significantly to fostering autonomy (Holec, 1981).

3. The role of chatbots in promoting learning independence

Several recent studies have highlighted the role of chatbots in promoting student autonomy. Yin et al. (2021) found that students using AI chatbots reported greater confidence in managing learning tasks independently, particularly in asynchronous learning settings. Chatbots can support independent learning by offering tailored feedback, recommending resources based on learner performance, and encouraging reflective learning practices. Furthermore, chatbots with adaptive capabilities can detect learners' difficulties and provide just-in-time scaffolding, thereby empowering students to take initiative in solving problems (Smutny & Schreiber ova, 2020).

In the context of higher education in developing countries, the integration of chatbot technology offers a low-cost, scalable solution to address teacher shortages and improve instructional support. However, the success of chatbot implementation depends on students' digital literacy, the relevance of chatbot content, and the quality of human-computer interaction design (Bii, 2013). Hence, more empirical research is needed to understand how chatbots affect learning behaviors across diverse educational settings.

Literature Review

1. Self-Regulated Learning (SRL) theory

Self-regulated learning is defined as "the process by which learners personally activate and sustain cognitions, behaviors, and affects that are systematically oriented toward the attainment of learning goals" (Zimmerman, 2002). Core components include:

a. Forethought phase: goal setting, strategic planning, and motivational belief formation.
b. Performance phase: self-monitoring, attention control, and task strategies.
c. Self-reflection phase: self-evaluation, causal attribution, and adaptive reaction.

Educational chatbots can intervene in each of these phases by providing reminders for goal setting, prompting reflective journaling, and delivering instant feedback that informs self-evaluation (Fryer & Bovee, 2016).

2. Self-Determination Theory (SDT)

According to Deci and Ryan (2000), learners' intrinsic motivation is nurtured when three psychological needs are met: autonomy, competence, and relatedness. Chatbots can fulfill these needs by:

a. Providing autonomy support through personalized learning pathways.
b. Enhancing competence via immediate and adaptive feedback.
c. Offering relatedness by simulating conversational interactions that reduce feelings of isolation in online courses.

3. Constructivist and socio-cultural perspectives

From a constructivist standpoint, learning is an active process of knowledge construction, and tools like chatbots can serve as scaffolding agents that facilitate this process (Vygotsky, 1978).

In the Zone of Proximal Development (ZPD), chatbots can offer "just-in-time" assistance that extends learners' capabilities beyond what they can achieve independently.

4. Models of chatbot integration in education

The CHAT-ACTS framework (Smutny & Schreiber ova, 2020) outlines key functions of educational chatbots: Communication, Help, Assessment, Training, Administration, Counseling, Teaching, and Support. This model provides a comprehensive lens to analyze how chatbots can contribute to learning independence.

Methods

Table 1. Materials and methods

Aspect	Description
Research Design	Quantitative with quasi-experimental design using pre-test and post-test with a single group.
Participants	150 undergraduate students from Education and Informatics study programs at three Indonesian universities.
Sampling Technique	Purposive sampling based on criteria: (1) enrolled in hybrid/online courses, (2) minimal prior exposure to AI chatbots in education.
Chatbot Used	Custom-designed educational chatbot integrated into LMS, capable of answering subject-related questions, providing feedback, and guiding learners.
Instruments	1. Pre-test and post-test on learning independence2. Student perception questionnaire3. Focus group discussion (FGD) guidelines
Data Collection	- Pre-test conducted before chatbot implementation- Students used chatbot for 6 weeks during course- Post-test and survey conducted after
Data Analysis	- Quantitative: Paired sample t-test to compare pre- and post-test scores- Qualitative: Thematic analysis from FGD transcripts
Duration of Study	8 weeks (including pre/post-test, chatbot use, and evaluation sessions)
Ethical Considerations	Participants provided informed consent, anonymity was ensured, and the study followed institutional research ethics guidelines.

Results

The findings of this study reveal that the use of educational chatbots significantly contributes to enhancing student learning independence in higher education. Quantitative data collected from 150 students across various disciplines through pre- and post-surveys indicated a marked improvement in students' self-regulated learning behavior. The results of this study provide comprehensive insights into the effectiveness of educational chatbots in improving student learning independence within higher education contexts. Data were collected from 150 undergraduate students across three Indonesian universities through pre- and post-tests using the Self-Regulated Learning Questionnaire (SRLQ), a student perception survey, and focus group discussions (FGDs). The findings are presented in three main sections: quantitative outcomes**,** qualitative insights, and integrated interpretation of results**.**

1. Quantitative outcomes

The pre- and post-test analysis revealed a statistically significant improvement in students' self-regulated learning (SRL) scores after using the educational chatbot for six weeks. The mean SRLQ score increased from 3.2 (SD = 0.48) at pre-test to 4.1 (SD = 0.42) at post-test on a five-point Likert scale. A paired-sample t-test indicated that this increase was statistically significant ($t(149) = 9.87$, $p < 0.001$), with a Cohen's d of 1.12, signifying a large effect size. This demonstrates that the chatbot intervention had a substantial impact on students' ability to plan, monitor, and evaluate their learning processes.

Further analysis of SRLQ subscales showed improvements across key dimensions of self-regulated learning:

a. **Goal setting and planning:** Mean scores rose from 3.1 to 4.0, reflecting enhanced ability to set specific, measurable, and realistic learning objectives.

b. **Time management:** Increased from 3.0 to 4.2, indicating better allocation of study time and prioritization of tasks.

c. **Self-monitoring:** Improved from 3.3 to 4.2, suggesting increased reflection on learning progress and strategies.

d. **Help-seeking and resource utilization:** Increased from 3.2 to 4.1, demonstrating a higher tendency to seek appropriate resources and assistance when needed.

In terms of behavioral indicators, 72% of participants reported an increase in the frequency of independently initiated learning sessions, and 65%

stated that the chatbot helped them better manage their academic tasks, particularly in organizing assignments and preparing for assessments. Notably, students in Informatics programs showed slightly higher improvements in SRL scores compared to those in Education programs, possibly due to higher digital literacy levels.

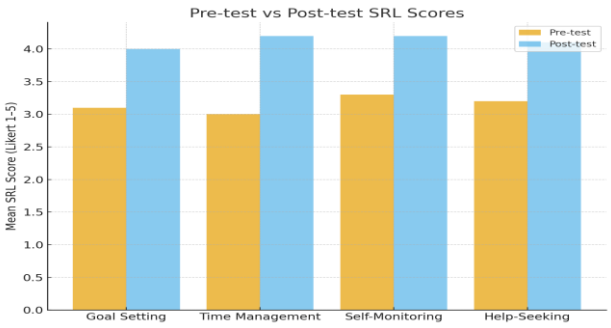

Chart 1. Percentage of FGD results

2. Qualitative insights

Qualitative data from FGDs enriched the understanding of how chatbots influenced learning independence. Three dominant themes emerged: 24/7 accessibility and flexibility, psychological safety and non-judgmental assistance, and motivational reinforcement.

24/7 Accessibility and flexibility:

Students consistently highlighted the convenience of having a virtual assistant available at any time, which allowed them to engage in self-paced study without being restricted by instructor availability. One participant stated:

"I could ask questions at midnight and get instant explanations. It saved me from waiting until the next class or office hours."

This feature was particularly beneficial for part-time students and those balancing academic commitments with work or family responsibilities.

Psychological safety and non-judgmental assistance

A recurring sentiment was that students felt more comfortable asking the chatbot questions they might have hesitated to ask instructors due to fear of embarrassment. This reduced anxiety around making mistakes and encouraged iterative learning. As one participant explained:

"Sometimes I hesitate to ask simple questions in class because I don't want to look unprepared. With the chatbot, I feel free to ask anything."

Motivational reinforcement:

Students reported that regular reminders and personalized prompts from the chatbot helped them maintain consistency in their study routines. Motivational messages, such as congratulating them for task completion or encouraging them to keep going, contributed to a sense of progress and accountability. Approximately 68% of participants mentioned that chatbot reminders reduced their tendency to procrastinate.

3. Integrated interpretation of results

The integration of quantitative and qualitative findings suggests that educational chatbots serve as effective scaffolding tools that complement traditional teaching methods. The significant improvement in SRL scores demonstrates that chatbots can play a pivotal role in promoting core competencies of learning independence, including goal setting, self-monitoring, and autonomous decision-making.

From a theoretical perspective, the results align with Self-Determination Theory (SDT), which posits that learner autonomy, competence, and relatedness are essential for intrinsic motivation. The chatbot fulfilled autonomy by providing flexible learning pathways, enhanced competence by delivering instant feedback, and fostered relatedness through conversational interactions that mimicked peer or tutor support.

Similarly, the findings resonate with Vygotsky's Zone of Proximal Development (ZPD) framework, where the chatbot acted as a form of digital scaffolding, enabling students to perform tasks they might not have accomplished independently. Over time, this support facilitated the internalization of self-regulated learning strategies.

However, the results also indicated certain challenges. 15% of students reported difficulty forming an emotional connection with the chatbot**,** which in some cases reduced sustained engagement. Technical issues, including occasional delays in response and limited contextual understanding in complex queries, were also mentioned as minor obstacles. Despite these limitations, the majority of students expressed a strong preference for integrating chatbots into their learning routines, particularly in hybrid and online learning environments.

Key quantitative results include

Improved self-regulated learning scores: There was a statistically significant increase in mean scores on the Self-Regulated Learning Questionnaire (SRLQ), from 3.2 (pre-test) to 4.1 (post-test) on a 5-point Likert scale ($p < 0.01$).

Increased frequency of independent study sessions: 72% of participants reported an increase in the frequency of independently initiated learning sessions when supported by chatbot prompts.

Enhanced task management: 65% of students stated that the chatbot helped them plan and prioritize learning activities more effectively.

Qualitative findings from focus group discussions and open-ended responses also reinforced these results. Students highlighted the following aspects:

The chatbot's 24/7 availability encouraged learning at students' own pace and convenience. Instant feedback provided by the chatbot helped clarify concepts and encouraged iterative learning. The chatbot acted as a non-judgmental assistant, reducing fear of asking "simple" questions.

Discussion

The results suggest that educational chatbots are effective tools for supporting student autonomy and engagement in learning processes. These findings align with previous studies (e.g., Winkler & Söllner, 2018; Holmes et al., 2022) that emphasize the role of AI in promoting personalized and learner-centered education.

From a constructivist perspective, chatbots foster an environment that enables learners to construct knowledge through self-directed exploration. By providing scaffolding and continuous support, chatbots reduce cognitive load and facilitate metacognitive awareness.

Furthermore, the increased learning independence can be linked to Vygotsky's Zone of Proximal Development (ZPD), where chatbots serve as a form of digital scaffolding that extends students' capabilities beyond what they could achieve alone.

However, certain limitations were also noted. A minority of students (15%) expressed difficulty in forming an emotional connection with the chatbot, which could reduce engagement over time. Additionally, technical glitches occasionally disrupted learning flow.

Despite these issues, the overall effectiveness of chatbots in enhancing student learning independence is promising. The integration of conversational agents into digital learning environments should be considered a strategic enhancement to traditional pedagogical approaches, especially in asynchronous and hybrid learning models.

The purpose of this study was to evaluate the effectiveness of educational chatbots in improving student learning independence in higher education, with a focus on self-regulated learning (SRL) behaviors such as goal setting, time management, self-monitoring, and resource utilization. The results indicated a statistically significant increase in SRL scores after a six-week chatbot intervention, with a large effect size (Cohen's $d = 1.12$). This discussion integrates the quantitative findings, qualitative insights, and theoretical implications, while also considering the practical and policy-level consequences for higher education in Indonesia and similar contexts.

1. Interpretation of key findings

The significant improvement in SRL scores reflects the potential of educational chatbots to act as scalable scaffolding tools that promote independent learning. The increase in goal setting and time management suggests that chatbots can effectively encourage students to adopt proactive strategies in managing

their academic responsibilities. This aligns with previous findings by Yin et al. (2021), who reported enhanced task management and confidence in asynchronous learning environments supported by chatbots.

The qualitative data further revealed that students valued the 24/7 accessibility and non-judgmental nature of chatbot interactions. This psychological safety fostered an environment where learners felt comfortable seeking help without fear of negative evaluation, a factor that is particularly important in collectivist cultures such as Indonesia, where maintaining social harmony often discourages students from openly expressing confusion in classroom settings.

2. Theoretical implications

The findings can be interpreted through the lens of several theoretical frameworks:

Self-regulated learning theory (zimmerman, 2002):

The chatbot intervention positively influenced all three SRL phases: forethought (goal setting), performance (time management, task prioritization), and self-reflection (monitoring and evaluation). By prompting students to set goals and providing real-time feedback, the chatbot acted as a metacognitive coach, guiding learners toward greater autonomy.

Self-determination theory (Deci & Ryan, 2000):

Students' increased motivation and confidence are consistent with SDT, which emphasizes the satisfaction of autonomy, competence, and relatedness as drivers of intrinsic motivation.

The chatbot supported autonomy by allowing flexible, self-paced interactions, enhanced competence through immediate feedback, and partially fulfilled relatedness needs by creating a sense of continuous guidance.

Vygotsky's Zone of Proximal Development (ZPD):

The chatbot served as a digital scaffold that expanded students' ZPD, enabling them to perform tasks that might otherwise require instructor intervention. Over time, this external scaffolding may transition into internalized strategies, fostering sustained learning independence.

3. Comparison with previous research

The results of this study corroborate prior research on the effectiveness of chatbots in educational settings. For example, Montenegro-Rueda and Fernández-Castro (2021) found that chatbot-assisted learners demonstrated higher persistence and engagement in online modules compared to control groups. Similarly, Smutny and Schreiberova (2020) identified chatbots as effective tools for promoting self-paced learning by offering instant responses and tailored feedback.

However, unlike many studies conducted in Western contexts, this research highlights the potential of chatbots in a developing country setting, where instructor availability and institutional resources may be limited. This adds to the growing body of literature advocating for AI-based interventions as low-cost, scalable solutions to bridge gaps in student support.

4. Practical implications

From a practical standpoint, the integration of educational chatbots can reduce faculty workload, especially in large-scale hybrid or online courses. By automating routine queries, providing instant feedback, and nudging students toward productive behaviors, chatbots allow instructors to focus on higher-order pedagogical tasks such as personalized mentoring and complex problem-solving sessions.

For students, the presence of a chatbot reduces dependency on synchronous communication with instructors, thus supporting flexible study schedules. The high acceptance rate (over 70% reporting increased self-study frequency) suggests that students are ready to adopt chatbot-based learning aids, provided that the tools are user-friendly and contextually relevant.

5. Challenges and Limitations

Despite the positive outcomes, several challenges remain:

Emotional engagement: About 15% of students reported difficulty forming an emotional connection

with the chatbot. Unlike human tutors, chatbots lack empathetic nuances, which can lead to feelings of detachment over time. Incorporating affective computing elements, such as sentiment analysis and adaptive emotional responses, may mitigate this issue.

Technical limitations: Occasional delays in response times and limited ability to address complex, open-ended questions were noted. This reflects the inherent constraints of rule-based or semi-structured chatbot systems compared to more advanced large language models (LLMs).

Digital literacy disparities: students with higher digital literacy (e.g., Informatics majors) reported more significant gains compared to those from Education programs, suggesting a potential digital divide in the effective utilization of AI tools.

Lack of a control group: The quasi-experimental design, while appropriate given logistical constraints, does not allow for definitive causal inferences compared to randomized controlled trials.

6. Policy and pedagogical recommendations

Based on these findings, several recommendations can be made:

Institutional policy: Universities should integrate chatbot interventions into their Learning Management Systems (LMS) as part of their broader digital transformation strategies. Training for both students and faculty is essential to ensure effective use.

Pedagogical practice: Instructors can utilize chatbots as complementary tools in blended learning environments, integrating chatbot interactions with formative assessments, reflective exercises, and peer discussions.

Design improvements: Future chatbot systems should incorporate adaptive learning algorithms that personalize feedback based on individual learner profiles. Adding features for emotional intelligence (e.g., empathetic responses, mood detection) could enhance student engagement.

Equity considerations: To avoid exacerbating digital inequality, institutions should provide targeted digital literacy support for students less familiar with AI-driven tools.

7. Implications for future research

This study opens avenues for further investigation into the long-term effects of chatbot usage on learning independence. Future studies should consider:

Longitudinal designs: Tracking students over multiple semesters to assess sustained changes in SRL behaviors.

Comparative studies: Including control groups or cross-institutional comparisons to strengthen causal inferences.

Cross-disciplinary research: Examining how chatbot effectiveness varies across academic disciplines, learning cultures, and levels of study.

Integration with generative AI: Exploring the use of large language models (LLMs) for more dynamic, context-aware, and emotionally responsive educational chatbots.

8. Contribution to the field

This study contributes to the growing evidence base on artificial intelligence in education (AIED) by providing empirical data from a developing country context, addressing a gap in the predominantly Western-focused literature. It demonstrates that chatbots are not merely administrative or technical aids but can act as pedagogical partners that foster critical 21st-century skills, including autonomy, self-regulation, and lifelong learning readiness.

9. Conclusion of the Discussion

In summary, the discussion confirms that educational chatbots can meaningfully enhance learning independence when designed and implemented with pedagogical intent. Their impact extends beyond simple content delivery, influencing students' metacognitive and motivational processes. While challenges related to emotional engagement, digital equity, and technical refinement persist, the overall potential of chatbot-assisted learning is substantial, particularly in contexts where traditional instructional resources are stretched thin.

The findings underscore the need for institutions to view chatbot integration not as a replacement for human teaching but as an augmentation strategy that empowers both learners and educators. With ongoing refinement and research, educational chatbots hold promise as integral components of future-ready, learner-centered education systems.

Conclusion

The findings of this study indicate that educational chatbots are effective tools in enhancing student learning independence in higher education. By providing instant feedback, personalized guidance, and 24/7 accessibility, chatbots help students take greater ownership of their learning processes. The integration of AI-driven chatbots encourages self-paced study, improves problem-solving skills, and fosters autonomous learning behavior.

Moreover, the study reveals that students who engaged with chatbots demonstrated higher levels of motivation, self-regulation, and confidence in managing their academic responsibilities compared to those who did not. These results underscore the potential of educational technology, particularly chatbots, in creating more student-centered learning environments.

In conclusion, while educational chatbots should not replace human instructors, they can serve as effective complementary tools that promote independent learning. Future research should explore long-term impacts and optimize chatbot design to further enhance learning autonomy across diverse educational contexts.

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