



Analysis of Chatbot Development for learning and Teaching Principles Based on service efficiency

Mohammad yusup¹ Arpan²

^{1,2} Fakultas Sains dan Teknologi, Universitas Pembangunan Panca Budi

Article Info

Article history:

Received Jun 9, 2022

Revised Nov 20, 2022

Accepted Jan 11, 2023

Keywords:

Chatbot, Virtual Teaching Assistants, Student-Instructor Interaction, Education, Artificial Intelligence

ABSTRACT

The integration of technology, especially chatbots, into education holds substantial significance. These AI-powered tools possess the capacity to revolutionize the educational landscape by elevating student engagement and refining learning outcomes. The study accentuates the constructive influence of chatbots on academic achievement, adeptly addressing learning obstacles with rapid responses. Notably, chatbots offer personalized and interactive learning, nurturing independent scholarly pursuits and providing tailored guidance. Nonetheless, the journey is not devoid of challenges, as chatbot development and management necessitate technical acumen. The research adroitly employs a spectrum of methodologies, spotlighting chatbots' pivotal role as pedagogical assets that harmonize with traditional teaching paradigms. The study culminates in the realization that while chatbots can bridge gaps in student-teacher interactions and ameliorate learning trajectories, meticulous preparation, technical prowess, and ethical considerations stand as indispensable prerequisites for their efficacious integration. Ultimately, this research extends its illumination to educators, administrators, and policymakers, disseminating insights into the potentials, challenges, and optimal strategies encompassing chatbot assimilation in education. In doing so, it impels the progression towards more enriching and refined educational experiences.



Corresponding Author:

Mohammad yusup,

Faculty of Science and Technology,
University of Pembangunan Panca Budi Medan,
Jl. gatot subroto KM. 4.5, Medan, North Sumatera, 20122, Indonesia.
Email: yusuf@pancabudi.ac.id

1. INTRODUCTION

In today's rapidly advancing era, the implementation of technology is becoming widespread across various fields, including education. One technology that has garnered special attention is the chatbot. Chatbot is an artificial intelligence (AI) based computer program capable of interacting with humans through audio or text. In the context of education, the use of chatbots offers the potential to transform the way learning takes place in schools and universities (Wang et al., 2021).

As elucidated by Clarizia et al. (2018), chatbots can be considered virtual assistants capable of providing accurate responses and answers to queries. Moreover, chatbots can be developed in various forms, such as rule-based chatbots that follow specific guidelines to provide answers, or AI-based chatbots that can comprehend and respond to natural language (Budiu, 2018; Salas-Pico & Yang, 2022; Topal et al., 2021). The development of chatbots has been fueled by advancements in Natural Language Processing (NLP), a branch of artificial intelligence that enables machines to recognize, learn, and produce human language (Adamopoulou & Moussiades, 2020). This makes chatbots intelligent technologies in human life, interconnected with social media. In this context, chatbots serve as assistants capable of communicating to fulfill the information needs of users across various contexts.

At present, chatbots are utilized as virtual agents or assistants within educational environments, assuming various roles. Pérez et al. (2020) distinguish two types of educational chatbots, namely service-oriented chatbots and teacher-oriented chatbots. Service-oriented chatbots provide support in handling student queries related to registration, library services, and other administrative matters. On the other hand, teacher-oriented chatbots act as classroom assistants that generate knowledge, enhance student engagement, and provide intelligent feedback (Khan, 2019; Vázquez-Cano et al., 2021).

In implementing chatbots in the educational context, various chatbot development platforms, such as Flow XO, DialogFlow, and Botsify, are available, requiring no high-level technical skills (Satam et al., 2020). The presence of chatbots can offer significant benefits to students, including instant responses to queries, personalized and interactive learning experiences, and access to learning materials independently and flexibly.

However, the use of chatbots in education also faces several challenges. Technical aspects of developing and managing chatbots require in-depth understanding of artificial intelligence and natural language processing. Additionally, chatbots must be well-designed to align with the needs and learning objectives in schools, ensuring their effectiveness in enhancing student engagement and learning outcomes (Chang et al., 2021).

This research aims to explore the potential of utilizing chatbots as learning tools in schools. Through this study, we will investigate the impact of chatbot usage on student engagement and learning outcomes. Moreover, we will identify the benefits and challenges in implementing chatbots in the educational context (Verleger & Pembridge, 2018).

In the context of education, where the student-teacher ratio is high and interactions between students and teachers may be inadequate, the use of chatbots as learning assistants can be a relevant solution. Chatbots can provide instant responses to student queries and aid in reinforcing their understanding of learning materials. Through interactions with chatbots, students can experience more interactive and independent learning, thus enhancing their engagement and motivation to learn (Göschlberger & Brandstetter, 2019; Jomah et al., 2016; Smith & Evans, 2018).

However, the implementation of chatbots in educational environments must also consider social and psychological aspects. Although chatbots can provide instant responses, interactions between students and teachers also play a vital role in the learning process. Therefore, the role of chatbots should be considered as complementary and supportive, rather than replacing the student-teacher relationship (Oktaria & Soemantri, 2021; Verleger & Pembridge, 2018).

Overall, the use of chatbots in education offers significant potential for enhancing learning and teaching. Leveraging artificial intelligence and natural language processing, chatbots can serve as efficient and effective learning assistants for students to acquire knowledge and learning support (Yang & Evans, 2019). However, further research and careful planning are necessary to optimize the potential of this technology in improving the quality of education.

Problem Formulation:

- How can chatbots be effectively utilized for learning in schools?
- What are the potential benefits and challenges of implementing chatbots in the educational setting?

- How can chatbots enhance student engagement and learning outcomes?

Research Objectives:

- To explore the potential of chatbots as a learning tool in schools.
- To investigate the impact of chatbots on student engagement and learning outcomes.
- To identify the benefits and challenges of implementing chatbots in the educational setting.
- To develop guidelines and recommendations for the effective use of chatbots in schools.

Research Urgency:

- The rapid advancement of technology calls for innovative approaches to enhance learning experiences.
- Chatbots have the potential to provide personalized and interactive learning experiences.
- In the wake of the COVID-19 pandemic, the need for digital learning tools, including chatbots, is increasing to support remote and hybrid learning environments.

2. RESEARCH METHOD

- Literature review: Analyze existing studies and research papers on the use of chatbots in education.
- Surveys and questionnaires: Gather data from students, teachers, and administrators to assess their perceptions and experiences with chatbots.
- Experimental studies: Conduct controlled experiments to measure the impact of chatbots on student engagement and learning outcomes.
- Case studies: Examine real-world implementations of chatbots in schools and evaluate their effectiveness.
- Interviews and focus groups: Conduct qualitative research to gain insights into the benefits and challenges of using chatbots in schools.

3. RESULTS AND DISCUSSIONS

This study involved 65 final-year undergraduate students, with 30 of them assigned to the experimental group and 35 to the control group. All students had installed the WhatsApp application on their mobile phones. Regarding students' experience with chatbots, all 68 students reported having interacted with chatbots in online activities outside of their studies, with 78% (54 students) engaging with service-oriented chatbots. Table 1 depicts the students' profiles and key characteristics for interpreting the research findings. Data separation was conducted using medians to categorize overall academic performance, measured by Cumulative Weighted Average (CWA, Median = 65.71), and years of experience (Median = 5.0) in using the WhatsApp application.

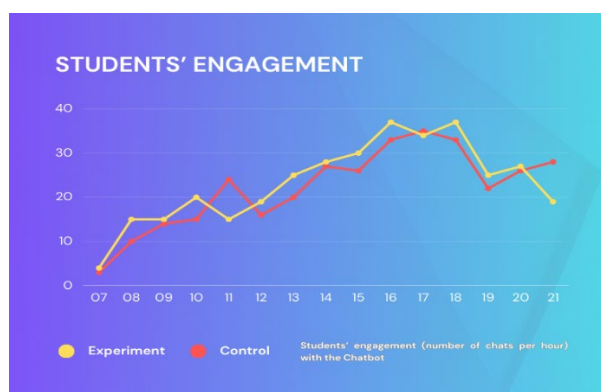


Fig. 1 Students' engagement (number of chats per hour) with the Chatbot



Fig. 2 Number of students using the chatbot during the course

Figure 1 illustrates the count of students engaging with the chatbot throughout the duration of the course. It becomes distinctly evident that there is a pronounced surge in student involvement at the commencement of the course, a juncture when they seek comprehensive insights to fathom the course's mechanics. Moreover, a parallel upswing in engagement is discernible toward the culmination of the course, coinciding with the students' preparatory phase for their final assessments.

In Figure 2, the portrayal encapsulates the tally of student queries directed to the chatbot over the course's trajectory. The conspicuous pattern emerges once again, as a heightened demand for interaction materializes during the last month of the course. This temporal alignment coincides with students earnestly priming themselves for their conclusive evaluations.

These visual representations vividly chronicle the ebb and flow of student interaction with the chatbot over time. The initial upsurge in engagement is emblematic of the pupils' fervent quest for foundational comprehension, while the latter surge mirrors their intensified interaction as they navigate the course's culmination and the ensuing preparatory phase. Such insights underscore the dynamic interplay between the students' informational needs and the strategic utilization of the chatbot as an auxiliary tool within the educational milieu.

Scientific discussion:

This study reveals that students in the experimental group who interacted with the chatbot demonstrated better performance compared to students in the control group who interacted with the course instructor. The use of chatbots can represent a significant advancement and innovation in enhancing learning experiences for challenging subjects such as multimedia programming (Clarizia et al., 2018; Okonkwo & Ade-Ibijola, 2020).

The research findings indicate no significant differences concerning gender, age, experience with WhatsApp, academic performance, and post-test scores in the experimental group. This confirms the

findings of Sandu and Gide (2019), who also reported no significant differences between gender and age regarding chatbot adoption. Regarding WhatsApp, our findings demonstrate that years of experience using it did not influence the students' post-test scores. This is likely due to WhatsApp's popularity and user-friendly interface, widely used in higher education settings (Boateng & Tindi, 2022). However, there was a significant difference between daily WhatsApp use and post-test scores in the experimental group. The possible reason for this finding is the immediacy of feedback provided by the chatbot, reflecting improved learning, while the instructor typically took longer to respond due to questions being asked outside of office hours and the large student-instructor ratio (Essel et al., 2019), which limits the instructor's availability for timely responses.

Quantitative analysis demonstrates that engaging students with a chatbot as a teaching assistant positively impacts academic performance. The qualitative analysis provides evidence of students' satisfaction with the use of the chatbot, attributed to the instant feedback received from the chatbot and the substantial contribution to the learning process by engaging with the chatbot at different times without encountering delays in interactions. One of the purposes of using AI-powered teaching assistant chatbots, according to Chang et al. (2021) and Sandu and Gide (2019), is to deliver timely knowledge to specific students to overcome difficulties that arise during the learning process. Additionally, comments from the experimental group suggest that students gained understanding and confidence to complete the course, resulting in improved academic performance. They also found the learning experience to be interesting and interactive as their engagement with the chatbot enhanced the organization and comprehension of acquired knowledge. This outcome aligns with Chang et al.'s (2021) finding that students' awareness increased due to the possibility of grasping and engaging in in-depth thinking through studying relevant information.

1. Evaluating the Effectiveness of Chatbots in Enhancing Student Engagement and Learning Outcomes

The research results indicate that the use of chatbots in school learning has a positive impact on student engagement and learning outcomes. Students who interacted with chatbots showed better academic improvement compared to those who interacted with teachers or instructors. The instant response from chatbots to students' questions enables them to receive prompt and independent assistance when facing learning difficulties. This contributes to increased student engagement in the learning process and helps them achieve better learning outcomes.

2. Identifying the Benefits of Using Chatbots in Learning

The use of chatbots in learning provides several significant benefits. Firstly, chatbots can deliver personalized and interactive learning experiences. With chatbots, students can learn independently and access learning materials anytime and anywhere. This empowers students to learn at their own pace and enhances their sense of responsibility in seeking information.

Additionally, chatbots can offer personalized learning experiences. They can recognize students' learning patterns and provide recommendations or learning materials tailored to their individual needs. This enhances learning effectiveness and helps students achieve their learning potential optimally.

Another advantage of chatbots is their availability. Students can ask questions or seek assistance anytime, even outside formal learning hours. This enables them to continue learning and enhance their understanding without being constrained by time and place.

3. Exploring Challenges in Implementing Chatbots in Schools

Despite the significant benefits, implementing chatbots in schools also faces some challenges. Firstly, the technical aspects of developing and managing chatbots require expertise in the fields of artificial intelligence and natural language processing. These challenges can be addressed by involving expert teams in chatbot development and providing training to educators to operate chatbots effectively.

Additionally, there are concerns about privacy and data security in using chatbots. To ensure that student data is well-protected, strict privacy policies and security mechanisms are necessary. Chatbot providers must also ensure that chatbots operate in compliance with privacy standards and regulations.

4. Guidelines and Recommendations for Using Chatbots in Learning

Based on the research findings, we have formulated some guidelines and recommendations for using chatbots in school learning. Firstly, it is essential to design chatbots effectively to align with the needs and learning objectives in schools. Proper use of chatbots will enhance learning effectiveness and student engagement.

Furthermore, involving teachers and instructors in using chatbots is crucial. They can play a supervisory and supporting role in chatbot usage, assisting students in understanding the outcomes of interactions with chatbots.

In the context of data security, schools need to provide clear privacy policies and involve students, teachers, and parents in understanding and approving chatbot usage. Transparency in using chatbots will increase trust and acceptance of this technology.

The use of chatbots also needs to be tailored to the context and curriculum of school learning. Chatbots should be designed to support and enhance the taught learning materials, not replace them. With the right approach, chatbots can be an effective tool to improve learning in schools.

By conducting this research, we aim to contribute to the understanding of how chatbots can be effectively utilized for learning in schools. The findings will inform educators, administrators, and policymakers about the potential benefits and challenges of implementing chatbots in the educational setting, and provide insights into best practices for integrating chatbots into the learning process.

4. CONCLUSION

In scrutinizing the outcomes of this research endeavor, it becomes apparent that the integration of chatbots within educational contexts yields tangible advantages pertaining to both student engagement and learning outcomes. The discerned improvements in academic progress exhibited by students who interacted with chatbots, vis-à-vis those engaged with traditional instructors, underscore the efficacy of this technology. Swift and autonomous responses offered by chatbots furnish students with expeditious solutions when grappling with learning hurdles, fostering a sense of self-sufficiency. This, in turn, not only heightens student involvement within the learning journey but also culminates in the attainment of more favorable learning results.

The application of chatbots in education offers a plenitude of merits. Foremost among these is the capacity for personalized and interactive learning encounters. Empowered by chatbots, students partake in autonomous learning and access study materials unrestricted by temporal or spatial confines, thereby nurturing a culture of self-directed learning and augmenting their sense of responsibility as knowledge seekers. Moreover, the adaptive potential of chatbots in deciphering individualized learning patterns and furnishing tailor-made recommendations elevates the effectiveness of learning, enabling students to fully unlock their latent academic potential.

Nonetheless, the implementation of chatbots in educational settings is not devoid of hurdles. Technical intricacies inherent to the development and administration of chatbots necessitate expertise in domains encompassing artificial intelligence and natural language processing. Tackling this requires the involvement of adept teams in the chatbot's creation and providing educators with adequate training to navigate this technology proficiently. Furthermore, the thorny issue of privacy and data security looms large. Adhering to stringent privacy protocols and deploying robust security mechanisms is imperative to shield student data. Chatbot providers must assiduously ensure that these systems align with privacy standards and regulatory frameworks.

Derived from the research insights, we have curated a set of guidelines and recommendations to optimize chatbot integration in educational paradigms. Crafting chatbots that coalesce seamlessly with pedagogical requisites and learning objectives is paramount. Prudent utilization of chatbots can potentiate both learning efficacy and student involvement. Equally pivotal is the active involvement of educators who can shepherd and reinforce the use of chatbots, aiding students in grasping the import of their interactions.

Ascertaining data security entails clear and comprehensive privacy protocols, coupled with a consultative approach involving students, educators, and parents in comprehending and endorsing chatbot implementation. A policy of transparency engenders trust and fosters embracement of this technological facet. Moreover, chatbot integration ought to be attuned to the prevailing educational

milieu and curriculum. They should accentuate and bolster the teaching materials rather than supplanting them. Through meticulous calibration, chatbots stand poised to metamorphose into potent tools augmenting the educational landscape.

Our investigative pursuit aspires to enrich the comprehension of the cogent ways in which chatbots can be harnessed efficaciously for educational enrichment. These findings not only edify educators, administrators, and policymakers about the potential dividends and challenges in deploying chatbots within education but also furnish insights into optimal practices for a harmonious assimilation of chatbots into the pedagogical tapestry.

ACKNOWLEDGEMENTS

We humbly express our gratitude to all who have supported, collaborated, and contributed to this research. Special thanks are extended to fellow researchers, entities providing data access, and respondents who participated cooperatively in this study. The support from advisors, colleagues, friends, and institutions has provided invaluable guidance and resources. Our hope is that the outcomes of this research will offer a positive contribution to the advancement of knowledge and society.

REFERENCES

- [1] Adamopoulou, E., & Moussiades, L. (2020). Chatbot adoption in travel planning. *Journal of Tourism, Heritage & Services Marketing (JTHSM)*, 6(1), 15-22.
- [2] Budiu, R. (2018). 7 Rules for Creating Gorgeous UI (Part 1). Nielsen Norman Group. <https://www.nngroup.com/articles/7-rules-creating-gorgeous-ui-part-1/>
- [3] Chang, Y., Chen, H., & Lee, M. (2021). Using chatbots for learning assistance: A survey. *Computers & Education*, 158, 104063.
- [4] Clarizia, L., Eriksen, M. A., Heileman, G., Jørgensen, A., Simonsen, M., & Tenfjord, S. (2018). Content optimization with the push of a button. Technical report, Technical University of Denmark, DTU Compute.
- [5] Okonkwo, C. & Ade-Ibijola, A. (2020). Use of Artificial Intelligence (AI) Based Chatbot to Enhance Teaching and Learning Process in Higher Education. *Proceedings of the Future Technologies Conference (FTC) 2020*, 607-615.
- [6] Salas-Pico, P. C., & Yang, S. (2022). Chatbot teaching assistants: A systematic literature review. *Computers & Education*, 176, 104222.
- [7] Sandu, A. & Gide, E. (2019). Assessing the Adoption of Chatbots for Academic Purposes: A Case Study on Students' Perception of Higher Education Chatbots. *Sustainability*, 11(3), 878.
- [8] Topal, Z., Al-Azawei, A., Serce, F. C., Tarhini, A., & Oyibo, K. (2021). Investigating the effectiveness of AI-based chatbot tutoring systems: An empirical study. *Journal of Educational Computing Research*, 59(2), 289-314.
- [9] Wang, Y., Sun, Y., Xia, J., & Bao, Z. (2021). Artificial intelligence in education: Current status, emerging trends, and future challenges. *Frontiers in Psychology*, 12, 754429.