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Evaluating the Usability of AI-Powered Chatbots in Informatics Learning at a Vocational High School Using the USE Framework

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Abstract

In the Society 5.0 era, education demands continuous, personalized technical support to facilitate independent and self-regulated learning. However, student-to-instructor ratios often impede the delivery of immediate scaffolding during practical sessions. To address this gap, this study aimed to develop and evaluate "Bot-Kom", an Artificial Intelligence-powered chatbot specifically designed for the 10th-grade "Computer Systems" module. Employing a Research and Development (R&D) methodology based on the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) framework, the system was engineered using a modern web stack (React and Node.js) and a hybrid AI architecture. This architecture integrated Google's Dialogflow for precise intent classification and OpenAI GPT for dynamic, natural language generation. A field evaluation was conducted involving 59 vocational students majoring in Computer and Network Engineering. Data collection employed the USE (Usefulness, Satisfaction, and Ease of use) Questionnaire. The results indicate that the deployed application can minimizes cognitive load through a user-centric interface and accurate Natural Language Understanding (NLU). The usability evaluation confirms that the chatbot meets standards across all four critical dimensions: Usefulness, Ease of Use, Ease of Learning, and Satisfaction. Ultimately, this study demonstrates that intelligently architected conversational agents can serve as highly accessible, engaging, and pedagogically robust tools, successfully bridging the gap between traditional classroom instruction and autonomous vocational practice.

1 Introduction

In the era of Society 5.0, vocational education faces the critical challenge of producing graduates with highly adaptive, industry-ready technical competencies. Informatics vocational learning, in particular, demands intensive hands-on practice, logical reasoning, and complex programming troubleshooting capabilities (Fitrihana & Nurdiyanto, 2023; Vilppola et al., 2022). Traditionally, students rely heavily on instructors to guide them through these rigorous practical sessions. However, the growing disparity in the student-to-instructor ratio often prevents the delivery of immediate, personalized technical support during independent study or laboratory work (May et al., 2023). When students encounter specific syntax errors or conceptual roadblocks in coding, delayed feedback can lead to a significant drop in learning

motivation and momentum. As the educational paradigm shifts toward ubiquitous and self-regulated learning, there is an urgent demand for intelligent, continuous support systems capable of bridging the gap between conventional classroom instruction and the independent, skill-based practice required in vocational informatics.

To address these instructional bottlenecks, the integration of Artificial Intelligence in Education (AIED) has seen a massive surge, particularly through the deployment of AI-powered chatbots as intelligent tutoring systems. Driven by the rapid advancement of Large Language Models (LLMs) and Generative AI, modern educational chatbots have evolved far beyond simple rule-based responders (Abedi et al., 2023). They now demonstrate exceptional capabilities in natural language understanding, allowing them to parse complex technical queries, generate specific code snippets, and provide step-by-step debugging explanations. Recent studies highlight that conversational AI can significantly enhance student engagement by simulating one-on-one tutoring, thus reducing extraneous cognitive load when students navigate difficult technical concepts (Ouaazki et al., 2024). By functioning as accessible virtual teaching assistants, these AI-powered tools offer 24/7 scaffolding, accommodate individual learning paces, and ultimately help mitigate instructor burnout by handling repetitive technical inquiries.

Despite the well-documented pedagogical affordances of AI-powered chatbots, the current body of literature predominantly focuses on either the algorithmic accuracy of the AI models or their direct quantitative impact on academic test scores. Consequently, there is a substantial "blind spot" in research concerning the Human-Computer Interaction (HCI) dimension, specifically the software usability of these conversational interfaces within specialized educational settings (Labadze et al., 2023). While an AI model might generate highly accurate technical answers, a poorly designed user interface or an unintuitive interaction flow can severely undermine its educational value. In vocational informatics, where efficiency and precision are paramount, students experiencing low system learnability, a lack of user control, or unhelpful chatbot responses will inevitably face high frustration and technology abandonment. Therefore, empirical and multidimensional evaluations of how vocational students interact with and perceive the software usability of these AI systems remain a critical research gap that must be addressed to ensure their effective, sustainable integration into technical learning environments.

To effectively measure these multidimensional aspects of chatbot usability, a robust and highly diagnostic evaluation instrument is required. While many existing studies rely on rapid, unidimensional tools such as the System Usability Scale (SUS) to gauge general system acceptability, such instruments often fail to capture the granular data necessary to determine whether the technology actually enhances the user's task performance (Lu et al., 2025). Consequently, this study adopts the USE (Usefulness, Satisfaction, and Ease of use) Questionnaire, a globally validated metric specifically designed to assess software quality by bridging the gap between functional utility and user experience. Unlike simpler tools, the USE framework provides a detailed usability profile across four critical dimensions: *Usefulness, Ease of Use, Ease of Learning,* and *Satisfaction* (Gao et al., 2018; Sunday et al., 2022). These dimensions are particularly highly relevant for evaluating conversational AI in educational settings. For instance, *Usefulness* measures whether the chatbot practically assists students in solving complex coding problems, while *Ease of Learning* evaluates how quickly students can adapt to prompting the AI effectively. By utilizing the USE framework, this research can move beyond superficial usability scores to determine not only if the chatbot is easy to operate, but whether it genuinely adds pedagogical value and satisfies the students' specific learning needs.

Addressing the aforementioned gaps, the primary objective of this study is to systematically evaluate the usability of AI-powered chatbots in the context of vocational informatics learning through the USE usability framework. Specifically, this research seeks to identify the usability strengths and critical bottlenecks of conversational interfaces as perceived by vocational students during independent programming practice. By doing so, this study offers a twofold academic contribution. Theoretically, it enriches the existing Human-Computer Interaction (HCI) literature within the domain of Artificial Intelligence in Education (AIED) by providing empirical evidence on how conversational agents are utilized in specialized, skill-driven environments. Practically, the findings of this evaluation will yield actionable

insights and evidence-based design guidelines for instructional designers, educators, and EdTech developers. Ultimately, these insights will facilitate the refinement of AI-powered chatbots, ensuring they are not only technologically accurate but also highly useful, satisfying, and pedagogically effective for future vocational education.

2 Methodology

2.1 Research Design

This study employed a Research and Development (R&D) methodology to systematically design, develop, and evaluate an Artificial Intelligence-powered chatbot tailored for vocational informatics learning (Umar et al., 2023). The primary objective of utilizing the R&D paradigm is not merely to investigate an educational phenomenon, but to produce a scientifically validated, functional technological product that addresses a specific instructional gap (Han & Lee, 2024). This approach ensures the developed chatbot is not only theoretically sound but also practically effective in enhancing learning outcomes within the vocational informatics domain.

To guide the development and evaluation process, this research adopted the ADDIE instructional design model, encompassing five iterative phases: Analysis, Design, Development, Implementation, and Evaluation (Shakeel et al., 2022). The ADDIE framework was specifically selected due to its structured, user-centered approach, which is highly effective for developing software-based educational technologies. By progressing through these systematic phases, the research ensures that the resulting chatbot is not only technologically robust and aligned with the vocational curriculum but also rigorously evaluated for its software usability and pedagogical effectiveness before widespread deployment (Nurwahyuddi & Dewanto, 2026). Specifically, the Analysis phase involved identifying the precise learning needs and characteristics of vocational informatics students, alongside the technical requirements for chatbot functionality (Zaky, 2023).

2.2 Participants and Setting

The research was conducted at a State Vocational High School (Sekolah Menengah Kejuruan/SMK) located in Central Java, Indonesia. The primary subjects for the field implementation and usability evaluation comprised 59 tenth-grade students enrolled in the Computer and Network Engineering (Teknik Komputer dan Jaringan) program. These students were specifically selected as the target demographic because their syllabus directly encompasses the "Computer Systems" module—covering hardware, software, and brainware (Hidayat et al., 2025)—which aligns with the core educational content integrated into the chatbot.

In addition to the student participants, the study involved two specialized validators to ensure the academic and technical integrity of the developed system prior to field testing. An experienced high school Informatics teacher was appointed as the Subject Matter Expert (SME) to assess the accuracy and pedagogical relevance of the instructional materials. Furthermore, a university lecturer specializing in Informatics Engineering Education served as the Media and Human-Computer Interaction (HCI) Expert. This expert was responsible for evaluating the software architecture, visual interface, and overall system navigation to ensure the application met standard educational technology guidelines before being deployed to the students.

2.3 Research Procedure

The procedure of this study was systematically executed through the five stages of the ADDIE model, as illustrated in Figure 1, providing a rigorous framework for the development and evaluation of the "*Bot-Kom*" application. The process commenced with the *Analysis* phase, which involved a comprehensive assessment of both pedagogical and technical requirements. During this stage, a content needs analysis was performed by reviewing the Informatics curriculum syllabus for 10th-grade vocational students, specifically focusing on the "Computer Systems" module. Simultaneously, a software functional analysis was conducted to determine the specific features, interaction capabilities, and technical constraints required to create an effective and responsive AI-powered learning assistant.

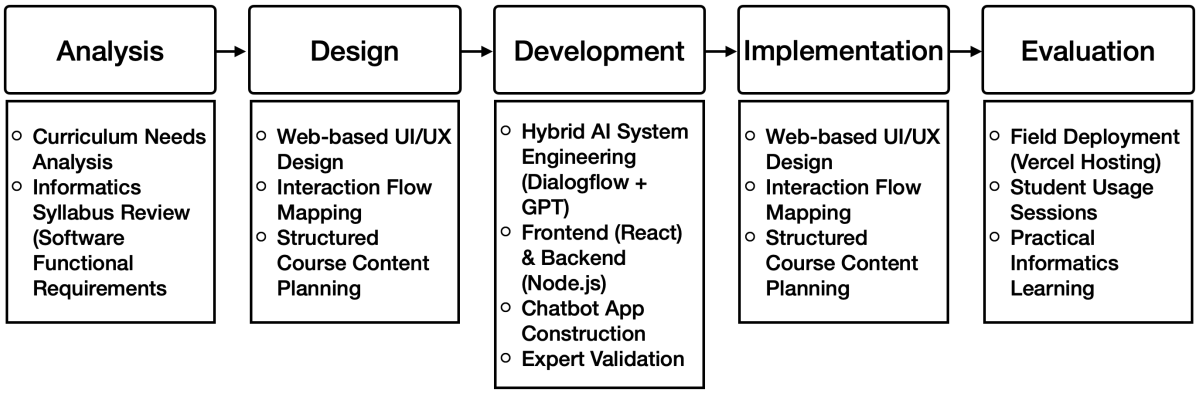

Figure 1. Research phases of this study

Subsequently, the research moved into the *Design* phase, where the conceptual blueprint for the interface and interaction flow was formulated. This phase prioritized the creation of a user-friendly, web-based interface that could accommodate the specialized needs of vocational students. The design focused on structuring the instructional content into six logical chapters and mapping the conversational logic to ensure that the chatbot could provide relevant and accurate guidance. Particular attention was given to the visual layout and navigation elements to ensure the application remained intuitive across various digital platforms, including laptops and smartphones.

The *Development* phase followed, focusing on the actual construction of the system using a modern technological stack. The application was built using the React framework for the frontend and Node.js for the backend, ensuring a robust and scalable architecture. To empower the chatbot with intelligent conversational capabilities, a hybrid AI approach was implemented by integrating the Dialogflow API for structured intent management and the OpenAI GPT API for generating natural, open-ended responses. Integral to this phase was the expert validation process, where the initial product was reviewed by subject matter and media experts. Their feedback was instrumental in refining the instructional materials and the technical interface before the system was finalized for field testing.

In the *Implementation* phase, the pplication was deployed via the Vercel hosting platform to be utilized by the target users in a real-world educational setting. A total of 59 students accessed the system using their personal devices during their Informatics practical sessions. During this stage, students interacted with the chatbot to explore the module, utilizing its interactive features for independent study. This phase was crucial for observing how the students navigated the system and for identifying any practical challenges encountered during live interaction with the AI-powered media.

The final stage, the *Evaluation* phase, was conducted to measure the overall success of the application and to determine its software usability. This summative assessment involved collecting quantitative data through the USE Questionnaire to analyze four critical dimensions: usefulness, ease of use, ease of learning, and user satisfaction. Furthermore, qualitative insights were gathered through open-ended questions to capture detailed student experiences and suggestions. The results from this phase provided the necessary data to perform a final refinement of the media, ensuring that the "*Bot-Kom*" chatbot was not only technologically advanced but also pedagogically effective, highly usable, and genuinely beneficial

for vocational informatics learning.

2.4 Evaluation Instrument and Data Analysis

To measure the usability level of the developed *Bot-Kom* application, this study employed the USE (Usefulness, Satisfaction, and Ease of Use) questionnaire instrument (Lund, 2001). This questionnaire was selected because it comprehensively evaluates not only the intuitiveness of the interface but also the software's practical utility in supporting user productivity. As illustrated in the instrument matrix, the questionnaire consists of 21 statement items systematically categorized into four primary dimensions: Usefulness, Ease of Use, Ease of Learning, and Satisfaction. The detailed items of the USE questionnaire, which have been contextualized for the Bot-Kom application, are presented in Table 1. Each item is assessed on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), enabling a granular evaluation of user perception across these dimensions (Cayola & Macías, 2018; Veral & Macías, 2018).

Table 1. USE Questionnaire indicators for the application

No	Dimension	Statement
1	**Usefulness**	The Bot-Kom website helps me be more effective.
2		The Bot-Kom website makes me more productive.
3		The Bot-Kom website is very useful.
4		The Bot-Kom application makes the things I want to accomplish easier to get done.
5		Using the Bot-Kom website saves me time.
6		The Bot-Kom website meets my needs.
7	**Ease of Use**	The Bot-Kom website is easy to use.
8		The Bot-Kom website is simple to use.
9		The Bot-Kom website is user-friendly.
10		I can use the Bot-Kom website without instructions.
11		I don't notice any inconsistencies as I use the Bot-Kom website.
12		I can use the Bot-Kom website successfully every time.
13	**Ease of Learning**	I learned to use the Bot-Kom website quickly.
14		I easily remember how to use the Bot-Kom website.
15		It is easy to learn to use the Bot-Kom website.
16		I quickly became skillful with the Bot-Kom website.
17	**Satisfaction**	I am satisfied with the Bot-Kom website.
18		I would recommend the Bot-Kom website to a friend.
19		The Bot-Kom website is fun to use.
20		The Bot-Kom website works the way I want it to work.
21		I feel I need to have the Bot-Kom website.

The data collected from the USE questionnaire were analyzed utilizing quantitative descriptive statistical techniques. The initial step in this analysis involved testing the instrument's reliability using Cronbach's Alpha to ensure the internal consistency and viability of the statement items before proceeding to further evaluation. Subsequently, the score for each dimension was calculated by aggregating the participants' response values (Chen et al., 2025). These aggregated scores were then normalized to a 0–100 scale to facilitate comparative analysis across different usability dimensions and against established benchmarks.

To determine the application's overall usability level, the obtained actual scores were compared against the ideal scores (the maximum achievable score) and converted into percentages using a standard feasibility percentage formula (Veral & Macías, 2018). The resulting percentages across the four dimensions were then classified into predefined feasibility interpretation categories: Highly Feasible, Feasible, Marginally Feasible, and Not Feasible. Through these percentages, it is possible to empirically identify the primary strengths of

Bot-Kom and pinpoint specific dimensions requiring further technical or pedagogical refinement (Lin et al., 2024). Meanwhile, qualitative data obtained from the open-ended questions were analyzed thematically to gather in-depth insights regarding specific constraints experienced by the students, as well as actionable interface improvement suggestions for future system iterations.

3 Results and Discussion

3.1 Results

The development of *Bot-Kom*, an AI-driven learning medium specifically designed for vocational informatics focusing on the *Computer Systems* module, was successfully realized through the systematic stages of the ADDIE model. The final product is a robust web-based application architected with a modern technology stack, utilizing the React framework for a responsive frontend and Node.js for a scalable backend. To manage complex conversational flows, the system leverages Google's *Dialogflow* API (Sabharwal & Agrawal, 2020). *Dialogflow* is a sophisticated Natural Language Understanding (NLU) platform that serves as the "*conversational brain*", enabling the chatbot to accurately interpret user intent and extract relevant entities from natural language inputs. The choice of *Dialogflow* was driven by its superior accuracy in intent classification and its seamless integration capabilities, which are essential for providing precise and contextually appropriate responses to technical student inquiries (Abedi et al., 2023; Sabharwal & Agrawal, 2020).

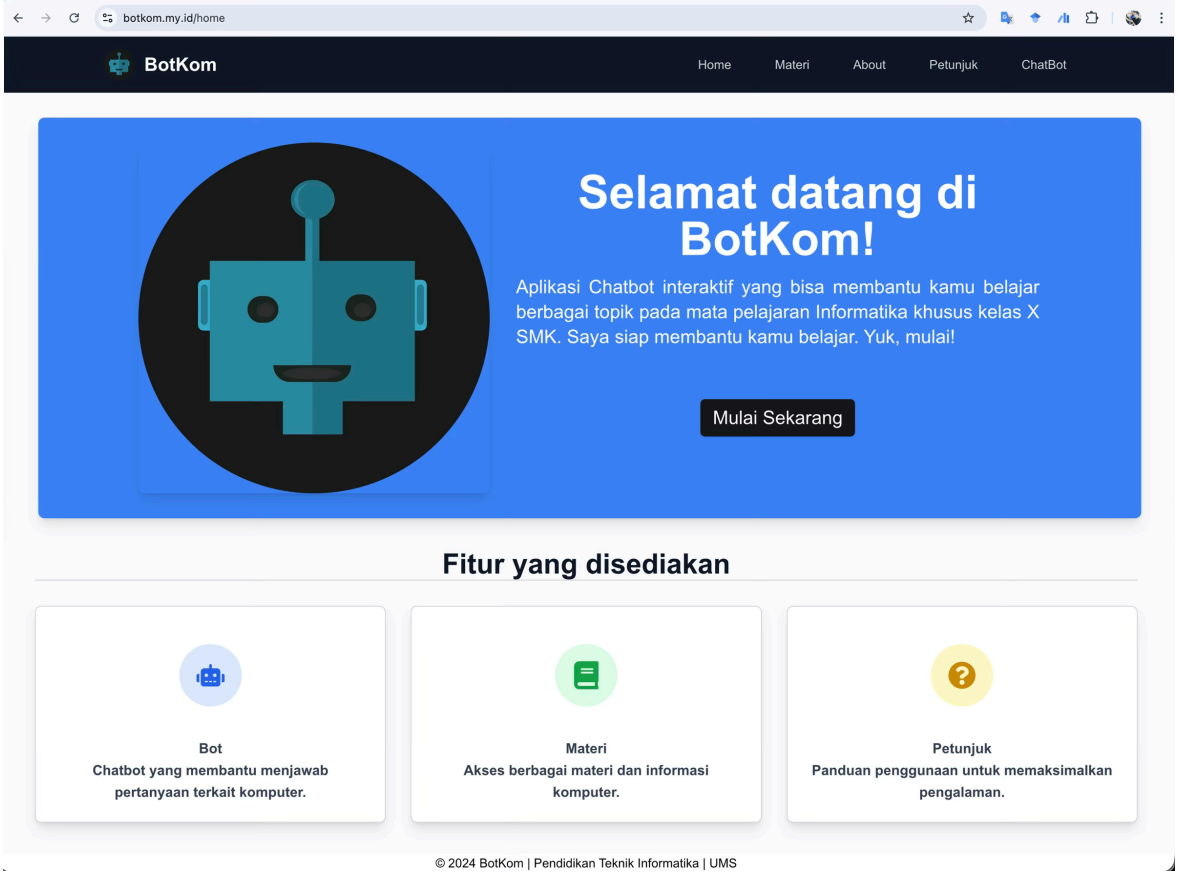

Figure 2. Landing page of the developed application

To ensure high accessibility, the application was deployed via the Vercel hosting platform. This cloud-based deployment allows for cross-platform flexibility, enabling students to access the learning materials seamlessly through various devices, including desktop computers and smartphones (Kumar et al., 2025). This ubiquitous access model ensures that the learning process is no longer confined to the physical classroom, fostering a self-paced and autonomous learning environment. As illustrated in Figure 2, the primary interface features a cohesive layout consisting of a header navigation menu, a personalized

welcome message, and a clear directory of available features. To initiate a learning session, students can navigate through three primary modules: the "*Bot*" menu for interactive AI consultation, the "Materi" menu—which contains six comprehensive chapters on computer hardware, software, and brainware—and the "Petunjuk" menu for user guidance.

Figure 3 showcases the intelligent chatbot interface, which acts as the core interactive component of the system. Upon activation, the chatbot initiates a proactive greeting, introducing its identity and functional capabilities to the user. To facilitate ease of navigation, the interface provides a selection of suggested queries, such as "Apa itu sistem operasi?" or "Apa itu hardware?". Nevertheless, the system is designed to allow students to type manual, open-ended questions according to their specific curiosities. A critical feature of this interface is its context-management logic; if a student submits a query that falls outside the predefined educational scope, the chatbot will politely inform the user that the question is irrelevant to the current informatics module. This context-filtering mechanism acts as a pedagogical guardrail, mitigating potential distractions and ensuring that the interaction remains focused on the prescribed learning trajectory and the specific informatics curriculum.

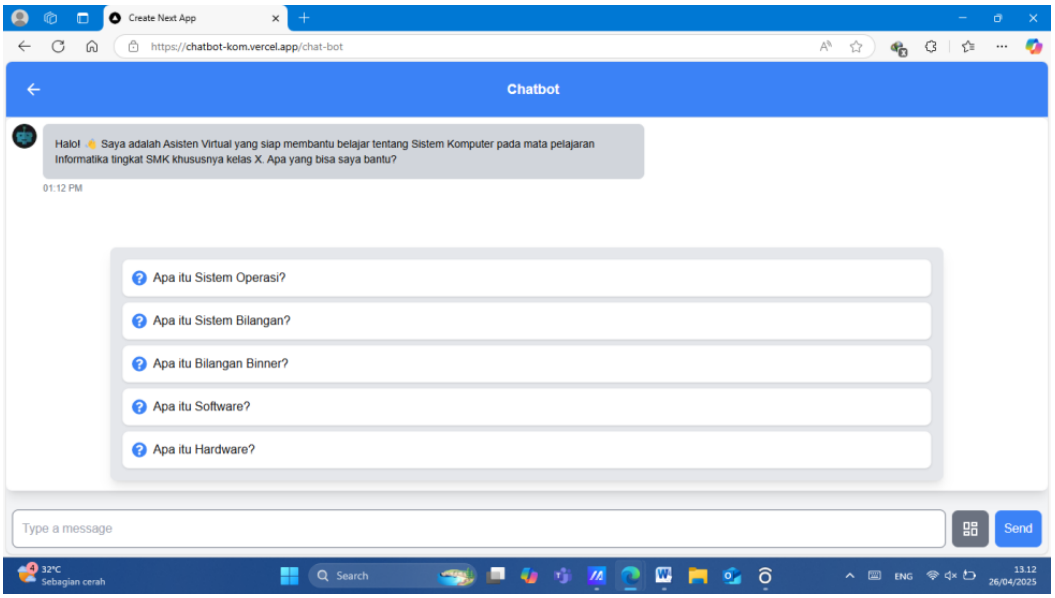

Figure 3. User interface of the chatbot app

Following the successful development and preliminary validation of the *Bot-Kom* application, the research proceeded to the Implementation phase. The system was field-tested in a real-world educational setting involving 59 tenth-grade students from the Computer and Network Engineering program. During these practical informatics sessions, students were instructed to access the web-based chatbot using their personal devices to independently study the *Computer Systems* module. This phase was crucial not only to observe how students interacted with the conversational AI but also to evaluate the real-time stability and cross-platform responsiveness of the system under concurrent usage.

The dynamics of this implementation phase are documented in Figure 4. Figure 4(a) illustrates the students simultaneously accessed the application using laptops and mobile devices, demonstrating the students' enthusiasm and the server's capacity to handle multiple active users without significant latency. Complementing this, Figure 4(b) provides a closer view of a student actively engaging with the *Bot-Kom* system via a smartphone. This specific interaction highlights the practicality of the mobile-optimized interface, showing how the student intuitively navigates the chat feature to ask specific hardware-related questions. Throughout this session, students explored the six learning chapters and utilized the AI assistant to clarify complex concepts, effectively simulating a self-directed learning environment facilitated by AI.

(a) (b)

Figure 4. Students trying the application

The USE questionnaire data was obtained after the students engaged with the application independently for approximately one lesson hour. Table 2 shows the aggregated scores, ideal scores, and feasibility percentages across the four primary dimensions of the USE framework: Usefulness, Ease of Use, Ease of Learning, and User Satisfaction. The comprehensive evaluation yielded a total overall usability score of 78.56% out of a maximum possible score of 6,195. Within standard educational software evaluation metrics, this cumulative percentage firmly places the application in the "*Good*" or "*Highly Feasible*" category, demonstrating that the system is practically viable, robust, and well-received by the vocational informatics students.

Table 2. Summary of USE questionnaire dimensions

Dimensions	Total Score	Ideal Score	Percentage
Usefulness	1,367	1,770	77.23%
Ease of Use	1,408	1,770	79.54%
Ease of Learning	934	1,180	79.15%
User Satisfaction	1,158	1,475	78.50%
Total Overall	**4,867**	**6,195**	**78.56%**

A detailed analysis of the individual dimensions reveals that the application performed exceptionally well in terms of its interface design and navigational flow. The Ease of Use dimension obtained the highest percentage at 79.54%, closely followed by the Ease of Learning dimension at 79.15%. These results strongly indicate that the students found the chatbot highly intuitive, allowing them to adapt to its interactive features rapidly and with minimal cognitive friction. Furthermore, User Satisfaction reached a solid 78.50%, reflecting a predominantly positive emotional response to the learning tool. Although the Usefulness dimension recorded the lowest relative score at 77.23%, it still remains well within the feasible threshold. This suggests that while the application is already highly user-friendly and enjoyable to operate, future developmental iterations could focus on deepening the chatbot's pedagogical capabilities to further maximize its perceived academic benefit for the students.

3.2 Discussion

The development of the AI-based educational medium, *Bot-Kom*, demonstrates a significant advancement in the integration of educational technology within vocational environments. Based on the established system architecture, the utilization of a modern technology stack, integrating *React* for the user interface and *Node.js* for the backend, successfully yielded a responsive and scalable software infrastructure. Beyond fundamental web functionalities, the integration of *Google's Dialogflow API* as the Natural Language Understanding (NLU) engine proved to be the most crucial element within this system. *Dialogflow* operates as the "*conversational brain*", capable of dissecting users' natural language intents with high precision. In the context of informatics vocational education, where students frequently pose specific and complex technical queries regarding "Computer Systems", the accuracy of this NLU directly contributes to the enhancement of the Usefulness dimension. This aligns with the findings of Dau et al. (2024) who assert that superior intent classification in educational chatbots critically determines student trust and the efficacy of the cognitive scaffolding provided when students encounter technical impasses.

In addition to its advanced language processing capabilities, the cloud-based deployment strategy via the Vercel platform yields transformative pedagogical implications. The resulting cross-platform accessibility ensures that learning materials are no longer confined by the physical boundaries of a classroom. Students' ability to access Bot-Kom seamlessly via desktop computers or smartphones substantially supports the realization of an autonomous, self-paced learning environment. This ubiquitous access serves as a vital catalyst in elevating the Ease of Use dimension. As articulated by Urooj & Farooq (2023), a flexible, anywhere-anytime learning infrastructure is fundamentally essential for facilitating the independent practical hours that constitute the core of vocational competencies.

From a Human-Computer Interaction (HCI) perspective, Bot-Kom's interface design exhibits a highly user-centered approach. The compartmentalization of features into three primary modules—the "Bot" menu for interactive consultation, the "Materi" (Material) menu for comprehensive literacy (comprising six chapters covering hardware, software, and brainware), and the "Petunjuk" (Instructions) menu for navigational guidance—functions effectively in minimizing the users' cognitive load. This cohesive navigational structure facilitates an intuitive transition between theoretical reading and collaborative problem-solving practice with the AI assistant. This lucid layout design not only prevents digital disorientation but also theoretically bolsters the Ease of Learning and user Satisfaction dimensions. Overall, the findings from the development of Bot-Kom corroborate that the success of AI educational media relies not merely on algorithmic sophistication, but fundamentally on how such technology is ergonomically integrated and strictly aligned with the practical demands of vocational education.

4 Conclusion

In conclusion, the development of the Bot-Kom application substantiate the transformative potential of integrating AI into vocational education. This study demonstrates that the true pedagogical efficacy of an educational chatbot extends far beyond its underlying algorithmic complexity; it relies fundamentally on the seamless synergy between sophisticated NLU and a user-centric software architecture. By leveraging a hybrid framework and cloud-based ubiquitous accessibility, the system successfully operationalizes the core dimensions of the USE usability framework. The precise intent classification engine significantly elevates the system's Usefulness in addressing complex technical inquiries, while the intuitive, well-structured interface ensures high Ease of Use and Ease of Learning. Consequently, these elements collectively foster a learning environment that minimizes cognitive overload and maximizes user Satisfaction.

Ultimately, this research provides empirical evidence that AI-powered conversational interfaces, when designed with a focus on human-computer interaction principles, can effectively bridge the gap between traditional classroom instruction and independent, self-regulated technical practice. The findings offer actionable guidelines for EdTech developers and educators to prioritize accessibility and intuitive navigation alongside AI accuracy. For future research, it is recommended to conduct longitudinal studies

to investigate the long-term impact of such conversational agents on actual academic achievement and coding proficiency, expanding the scope beyond usability to measure direct cognitive learning outcomes in diverse vocational disciplines.

References

Abedi, M., Alshybani, I., Shahadat, M., & Murillo, M. S. (2023). *Beyond Traditional Teaching: The Potential of Large Language Models and Chatbots in Graduate Engineering Education*. https://doi.org/10.32388/md04b0.2

Cayola, L., & Macías, J. A. (2018). Systematic guidance on usability methods in user-centered software development. *Information and Software Technology*, *97*, 163–175. https://doi.org/10.1016/j.infsof.2018.01.010

Chen, W., Huang, Z., Peng, X., Li, L., & Chen, J. (2025). Teacher competency and work engagement among secondary school physical education teachers: The multiple mediating roles of occupational stress, emotional exhaustion, and professional achievement. *Frontiers in Psychiatry*, *16*, 1530413–1530413. (39963334). https://doi.org/10.3389/fpsyt.2025.1530413

Dau, S., Jensen, C. G., & Gade, P. (2024). The role of AI chatbots in scaffolding: Linking learning outcomes with assessment. *Learning Tech*, (14), 73–97. https://doi.org/10.7146/lt.v9i14.141213

Fitrihana, N., & Nurdiyanto, H. (2023). Improving Student Competence through Informatics-Based Vocational Education. *International Journal of Artificial Intelligence Research*, *7*(2), 226–226. https://doi.org/10.29099/ijair.v7i2.1180

Gao, M., Kortum, P., & Oswald, F. L. (2018). Psychometric Evaluation of the USE (Usefulness, Satisfaction, and Ease of use) Questionnaire for Reliability and Validity. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *62*(1), 1414–1418. https://doi.org/10.1177/1541931218621322

Han, J., & Lee, D. (2024). Research on the development of principles for designing elementary English speaking lessons using artificial intelligence chatbots. *Humanities and Social Sciences Communications*, *11*(1). https://doi.org/10.1057/s41599-024-02646-w

Hidayat, R., Rian, R. A., Herlandy, P. B., & Novalia, M. (2025). Computika: A Mobile-based Interactive Learning Media for Computer Systems Subject in Vocational High Schools. *SISTEMASI*, *14*(6), 3070–3070. https://doi.org/10.32520/stmsi.v14i6.5715

Kumar, A., Singh, A., & Singh, P. (2025). Scalable Deployment of React Apps using Serverless Architecture. *2025 3rd International Conference on Sustainable Computing and Data Communication Systems (ICSCDS)*, 1954–1959.

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*(1). https://doi.org/10.1186/s41239-023-00426-1

Lin, M. P.-C., Chang, D., & Winne, P. H. (2024). A proposed methodology for investigating student-chatbot interaction patterns in giving peer feedback. *Educational Technology Research and Development*. https://doi.org/10.1007/s11423-024-10408-3

Lu, J., Schmidt, M., & Shin, J. (2025). Beyond Technological Usability: Exploratory Factor Analysis of the Comprehensive Assessment of Usability for Learning Technologies (CAUSLT) Scale. *arXiv (Cornell University)*. https://doi.org/10.48550/arxiv.2501.18754

Lund, A. M. (2001). Measuring usability with the use questionnaire12. *Usability Interface*, *8*(2), 3–6.

May, D., Alves, G. R., Kist, A. A., & Zvacek, S. (2023). Online Laboratories in Engineering Education Research and Practice. In *Routledge eBooks* (pp. 525–552). Informa. https://doi.org/10.4324/9781003287483-29

Nurwahyuddi, N., & Dewanto, A. (2026). Development of a Chatbot-Based Assessment System for Evaluating Career Readiness in Vocational Education. *Jurnal Paedagogy*, *13*(1), 187–199. https://doi.org/10.33394/jp.v13i1.18781

Ouaazki, A., Bergram, K., Farah, J. C., Gillet, D., & Holzer, A. (2024). Generative AI-Enabled Conversational

Interaction to Support Self-Directed Learning Experiences in Transversal Computational Thinking. *ACM Conversational User Interfaces 2024*, 1–12. https://doi.org/10.1145/3640794.3665542

Sabharwal, N., & Agrawal, A. (2020). Introduction to Google Dialogflow. In N. Sabharwal & A. Agrawal (Eds.), *Cognitive Virtual Assistants Using Google Dialogflow: Develop Complex Cognitive Bots Using the Google Dialogflow Platform* (pp. 13–54). Apress. https://doi.org/10.1007/978-1-4842-5741-8_2

Shakeel, S. I., Mamun, M. A. A., & Haolader, M. F. A. (2022). Instructional design with ADDIE and rapid prototyping for blended learning: Validation and its acceptance in the context of TVET Bangladesh. *Education and Information Technologies*, *28*(6), 7601–7630. (36532794). https://doi.org/10.1007/s10639-022-11471-0

Sunday, K., Oyelere, S. S., Agbo, F. J., Aliyu, M. B., Balogun, O. S., & Bouali, N. (2022). Usability Evaluation of Imikode Virtual Reality Game to Facilitate Learning of Object-Oriented Programming. *Technology Knowledge and Learning*, *28*(4), 1871–1902. https://doi.org/10.1007/s10758-022-09634-6

Umar, U., Purwanto, M. B., & Firdaus, Moch. M. A. (2023). RESEARCH AND DEVELOPMENT: AS THE PRIMARY ALTERNATIVE TO EDUCATIONAL RESEARCH DESIGN FRAMEWORKS. *JELL (Journal of English Language and Literature) STIBA-IEC Jakarta*, *8*(1), 73–82. https://doi.org/10.37110/jell.v8i01.172

Urooj, S., & Farooq, M. S. (2023). Impact of Students' Ubiquitous Learning through Web 2.0 Tool on Students' 21st Century Skills: Critical Thinking and Collaboration. *Sjesr*, *6*(3), 29–43. https://doi.org/10.36902/sjesr-vol6-iss3-2023(29-43)

Veral, R., & Macías, J. A. (2018). Supporting user-perceived usability benchmarking through a developed quantitative metric. *International Journal of Human-Computer Studies*, *122*, 184–195. https://doi.org/10.1016/j.ijhcs.2018.09.012

Vilppola, J., Lämsä, J., Vähäsantanen, K., & Hämäläinen, R. (2022). Teacher Trainees' Experiences of the Components of ICT Competencies and Key Factors in ICT Competence Development in Work-Based Vocational Teacher Training in Finland. *International Journal for Research in Vocational Education and Training*, *9*(2), 146–166. https://doi.org/10.13152/ijrvet.9.2.1

Zaky, Y. A. M. (2023). Chatbot Positive Design to Facilitate Referencing Skills and Improve Digital Well-Being. *International Journal of Interactive Mobile Technologies (iJIM)*, *17*(9), 106–126. https://doi.org/10.3991/ijim.v17i09.38395