Design, Implementation, and Evaluation of a Chatbot to Enhance Inclusive Learning through Universal Design for Learning in University Students[1]

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Abstract
Currently, there are various artificial intelligence tools, such as natural language processors, which are used to enhance teaching and learning processes. In this context, the use of virtual assistants is becoming increasingly common

in higher education institutions. This study addresses the design, implementation, and evaluation of a chatbot designed to improve inclusive learning in university students. This artificial intelligence–based system was implemented with undergraduate and postgraduate students in the field of education at Universidad Europea de Madrid. To achieve this, an exploratory and descriptive study with a mixed-methods approach was conducted. A self-perception questionnaire was used as a research instrument to evaluate usability, accuracy, interaction, utility, and satisfaction criteria, along with gathering qualitative feedback. The results revealed highly positive student evaluations of the chatbot, consistently surpassing average ratings of 4.2 out of 5. Furthermore, the correlation between satisfaction with the chatbot and other questions regarding usability, accuracy, interaction, and utility showed direct and significant correlations in all cases. In conclusion, this virtual and conversational assistant proves to be a valuable practice in future chatbot designs for enhancing inclusive learning based on Universal Design for Learning.

Keywords: conversational agent, virtual assistant, Universal Design for Learning, chatbot, higher education.

7.1. Introduction

In recent decades, educational technology has had a significant influence on teaching and learning processes (Zorrilla-Puerto et al., 2023), as well as for student engagement (Ruiz-Lázaro et al., 2024). Particularly, artificial intelligence (AI) has emerged as a key factor, marking a transformation in the conception of the educational process (Jiménez-García et al., 2024; Redondo-Duarte et al., 2024). In the context of higher education, its integration has been driven by the widespread availability of large language models (LLM). In this regard, many authors highlight the role of educational chatbots in the learning process (Kuhail et al., 2023; Wu & You, 2023; Wang et al., 2021; among others).

Conversational assistants in higher education

Chatbots are intelligent systems capable of adapting to individual student needs, offering personalized and contextual interactions, and facilitating student-machine communication (Okonkwo & Ade-Ibijola, 2021; Redondo-Duarte et al., 2024). In other words, chatbots engage with students through chat or conversa-

tion, providing automated information and guidance (Baltazar, 2023). In the context of higher education, these tools stand out for their ability to perform various functions, such as administrative, technical, and/or academic guidance, virtual tutoring, and personalized conversational academic support.

Recent studies have highlighted the usefulness of chatbots in improving academic outcomes, demonstrating enhancements in student learning and engagement compared to traditional teaching methods (Kuhail et al., 2023). While they offer benefits such as flexibility and accessibility, it is essential to ensure equitable, responsible, and ethical implementation, as well as to enhance the understanding of human emotions (Pack & Maloney, 2023; Tseng & Warschauer, 2023; Yeo, 2023).

Universal Design for Learning for inclusive education through AI-based conversational agents

The Universal Design for Learning (hereafter, UDL) has emerged as a conceptual model aiming to address inclusivity and student diversity (CAST, 2018) through flexible and equitable learning environments (Meyer et al., 2014). It also seeks to overcome limitations and barriers of traditional educational models by recognizing the inherent heterogeneity among students in terms of learning styles, skills, and specific needs (Burgstahler, 2015). In this vein, UDL stands out as a distinct approach not only focused on adapting materials and instructional resources but also committed to addressing teaching and learning methods, strategies, and various modes of educational assessment (Elizondo, 2023). In this context, educators play a crucial role, as they need to tailor their teaching methods to the needs of each student (cultural, linguistic, and socioeconomic, among others), taking into consideration potential factors that may impact its implementation, such as time constraints and the number of students in the classroom (Shahmoradi et al., 2018).

Some natural language processing techniques, such as chatbots, emerge with the purpose of providing personalized learning that caters to the diversity of students. The use of chatbots in the educational context presents a significant opportunity for future teaching professionals to learn how to apply UDL in their daily teaching practices and create inclusive and equitable environments tailored to the needs of their students.

For this reason, the overall objective of this study was to assess the self-perception of university students regarding the implementation of a chatbot specifically designed to enhance learning linked to UDL. The specific objectives are five:

a) Evaluate the usability of the chatbot in the context of learning about UDL.
b) Analyze the accuracy of the chatbot in delivering information related to the principles of UDL.
c) Investigate the quality of interaction provided by the chatbot during the learning process about UDL.
d) Measure the utility of the chatbot as a support tool in understanding and applying UDL concepts.
e) Assess the satisfaction of university students regarding the implementation of the chatbot to enhance learning about UDL.

7.2. Methodology

To conduct this study, an exploratory and descriptive research approach with a mixed-methods design was employed.

Participants

The study sample consisted of N=28 undergraduate and postgraduate students in the field of education at Universidad Europea de Madrid. The participants were selected from various stages, including both undergraduate and postgraduate levels, to ensure diversity in study programs. A total of 82.1% were students in the face-to-face Primary Education degree program, specifically in the Diversity Attention course, whereas 17.9% were postgraduate students specializing in Educational Guidance, specifically in the Development, Learning, and Education course.

Strategies and instruments

To achieve the study's objective, a self-perception instrument was applied, specifically designed with a total of 8 items on a Likert scale ranging from 0 to 5 (where 0 indicates totally disa-

gree and 5 indicates totally agree). The instrument evaluates five dimensions: usability, accuracy, interaction, utility, and student satisfaction with the chatbot. Additionally, this scale was complemented with other questions related to general dimensions to provide additional information and qualitative feedback, aiming to gather more detailed perceptions about the student experience.

Chatbot design

The chatbot was developed using advanced natural language processing and machine learning technologies. An intuitive chat interface was designed to allow students to interact naturally with the chatbot. The content was structured to address the fundamental principles of UDL, providing clear information and relevant examples. Interactive features, such as adaptive questions and answers, were implemented to personalize the learning experience based on individual student responses and needs.
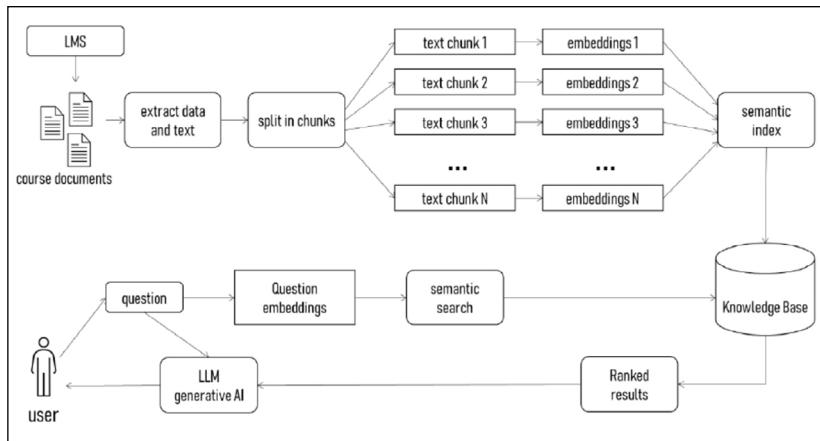
Figure 7.1. General architecture of the system. Source: developed by autor.

Chatbot implementation

The use of the Chatbot was integrated into specific teaching related to UDL, where students could access it as an additional tool to enhance their understanding and application of concepts taught in class.

The process began with a brief introduction to the chatbot and guidance on how to access and use the tool. The participants were given a defined period to interact with the chatbot and explore its functions, which comprised two class sessions. Below are several examples of interaction with the chatbot:
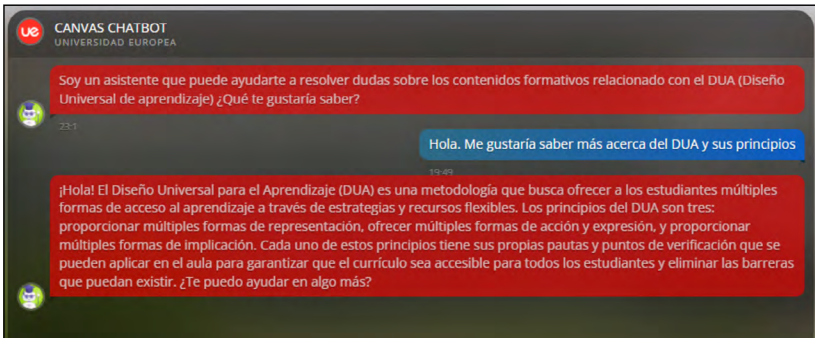

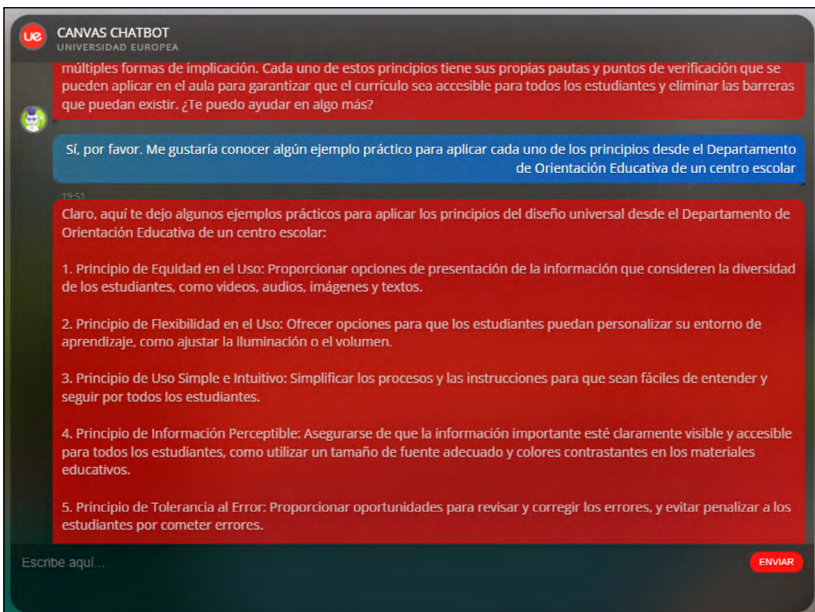**Figure 7.2.** Interaction Example 1 with the chatbot on UDL. Source: developed by autor.

Figure 7.3. Interaction Example 2 with the chatbot on UDL. Source: developed by autor.

Chatbot evaluation

The study was conducted using a non-random convenience sampling approach. Students from in-person undergraduate and semi-presential postgraduate programs at Universidad Europea de Madrid were selected, specifically those who were part of the classes where the researchers taught. An invitation to participate in the research was sent, providing a detailed explanation of the study's objectives and the role of the chatbot designed to enhance learning about UDL. Participation was entirely voluntary, and informed consent was obtained from each student before their inclusion in the study, ensuring data anonymity.

Subsequently, structured questionnaires were administered to gather data on the perceived usability, accuracy, interaction, utility, and satisfaction of students regarding the chatbot. Additionally, demographic data were collected for descriptive and exploratory analyses.[2]

7.3. Results

Descriptive results

All evaluations provided by students regarding the chatbot were highly positive (Table 7.1), consistently surpassing the threshold of 4.2 out of 5 in all cases. The utility of the chatbot stood out with the highest average rating, reaching 4.75/5, demonstrating its effectiveness and relevance for students. Similarly, the usability of the chatbot was highlighted, achieving an average score of 4.68/5, emphasizing its user-friendly nature. In the interaction dimension, students perceived the chatbot's ability to understand their questions satisfactorily, giving it an average score of 4.54/5. In terms of overall satisfaction, the participants expressed a high level of contentment, with an average score of 4.54.

These results indicate that the chatbot was not only perceived as useful and efficient but also generated a satisfactory experience for the students.

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2. Bellow is the <u>link to the questionnaire</u>.

Table 7.1. Descriptive results of the ad hoc self-perception instrument

| DIMENSION	ITEMS	MEAN	ST
Usability	Usability1: State whether you found the chatbot easy to use.	4.68	0.61
	Usability2: Were you able to resolve your doubts quickly and efficiently?	4.43	0.74
Accuracy	Accuracy1: Were the responses provided by the chatbot accurate?	4.21	0.63
	Accuracy2: Did you find the information you were looking for?	4.29	0.90
Interaction	Interaction1: Did the chatbot understand your questions correctly?	4.54	0.79
Utility	Utility1: State whether you found the chatbot useful.	4.75	0.52
Satisfaction	Satisfaction1: How satisfactory was your experience with the chatbot?	4.54	0.58
	Satisfaction2: Did the chatbot help you resolve your doubts, understand information better, or prepare for any assessments?	4.36	0.63

Source: developed by autor.

## Other results based on the usability, accuracy, interaction, and utility of the chatbot

The result of the remaining questions posed to the students about usability (Figure 7.4) shows that 86% of the students took less than 5 minutes; on the other hand, 61% indicated that the chatbot was accessible from the PC.

Regarding accuracy and interaction (Figure 7.5), 93% of the participants stated that there were no incorrect or confusing responses, reflecting highly positive outcomes in terms of accuracy. As for interaction, once again, the results were highly satisfactory, with 68% of students indicating that the chatbot adequately informed them if it could not understand or answer their question.
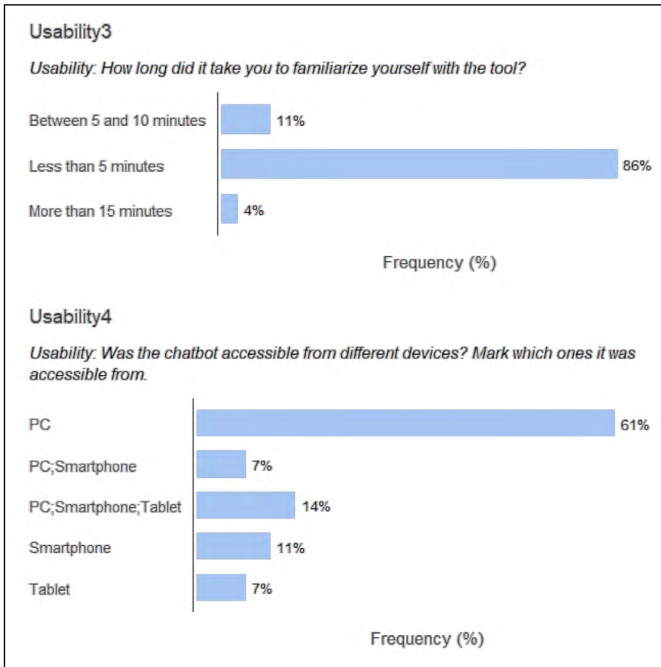
Figure 7.4. Other questions about usability.
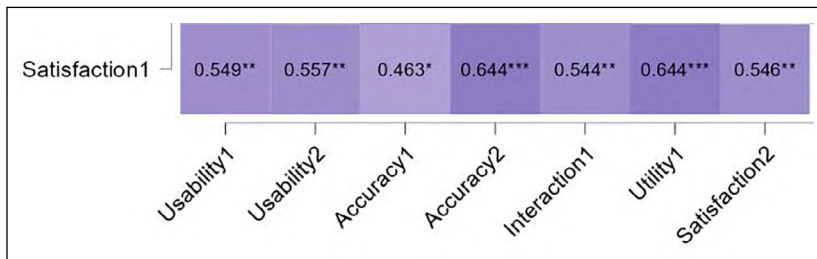Source: developed by author using Jamovi 2.4. software.
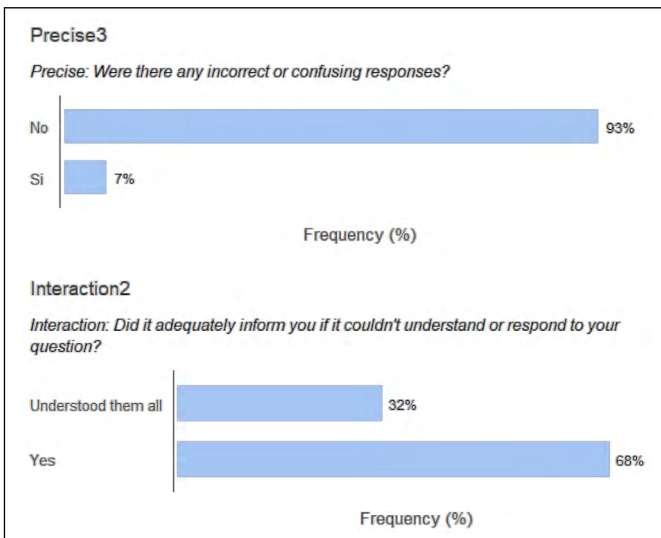
Figure 7.5. Other questions about accuracy and interaction.
Source: developed by author using Jamovi 2.4. software.

Regarding the questions Utility2: Do you consider the chatbot useful from an educational perspective? And Satisfaction3: would you like to have a chatbot trained to assist you with all the subjects you are studying? 100% of the students answered yes.

Results based on chatbot satisfaction

Below are the results of the correlation between satisfaction with the chatbot experience and the rest of the questions. The results of the correlation analyses (see Figure 7.6) show direct and significant correlations in all cases (p = 0.05), indicating that higher satisfaction with the chatbot is associated with higher ratings from students in terms of usability, accuracy, interaction, and usefulness.

In terms of the intensity of the relationship, it is moderate in all cases, with the correlations between Satisfaction1 and Accuracy2 (r = 0.644) standing out more prominently. This means that, as satisfaction with the experience increases, so does the assessment of finding the sought information. The same holds true for Satisfaction1 and Utility1 (r = 0.644), indicating that, as satisfaction with the experience increases, the evaluation of the chatbot's utility also increases.

Figure 7.6. Correlations analysis. Source: developed by author using JASP 0.18.1.0 software.
Note. p < .05, ** p < .01, *** p < .001
Spearman's correlation coefficient: r = 0 no correlation; r < 0.2 very weak correlation; r between |0.20|and|0.40|weak correlation; r between |0.40|and|0.70|moderate correlation; r between |0.70|and|0.90|strong correlation; r >|0.90|very strong correlation; r = 1 perfect correlation.

7.4. Conclusions and Discussion

The use of virtual assistants is becoming increasingly common in higher education institutions. In this context, chatbots engage with students through chat or conversation, providing information and advice in an automated manner. This study addresses the design, implementation, and evaluation of a chatbot designed to enhance inclusive learning in university students. The overall objective of this study was to assess the self-perception of university students regarding the implementation of a chatbot specifically designed to enhance learning linked to UDL. The following are the conclusions of the study.

Firstly, regarding the usability of the chatbot in the context of learning about UDL, a positive reception from students was evident. The interface and navigation of the chatbot were rated as intuitive, facilitating interaction and access to information related to UDL. This finding suggests that the implementation of virtual assistants can contribute to improving accessibility and the user experience in educational environments since, as noted by Benito-Sánchez (2023), the implementation of virtual assistants can mitigate accessibility barriers and diversify learning strategies. Furthermore, the chatbot's ability to adapt to individual needs, as mentioned by Mateos (2023), demonstrates the potential for personalization in education, aligning with the principles of UDL.

Secondly, regarding the accuracy of the chatbot in delivering information related to the principles of UDL, the results indicate that the chatbot proved to be accurate and reliable in conveying key concepts. This aspect is crucial to ensure that the provided information is educationally sound, thereby supporting the chatbot's effectiveness as a reliable learning resource. The accuracy and reliability of this tool in delivering information align with the research of Gauna-Ferraz et al. (2024), who emphasize the importance of accuracy in AI-based educational interactions. On the other hand, the observed smooth interaction supports the conclusions of Villavicencio et al. (2021) regarding the enhancement of user experience through natural conversation systems.

Thirdly, concerning the quality of the interaction provided by the chatbot during the learning process about UDL, a smooth and contextualized communication was observed. Therefore, in line with studies such as Okonkwo & Ade-Ibijola (2021) and

Redondo-Duarte et al. (2024), it is affirmed that the chatbot's ability to adapt to the individual needs of students can provide personalized responses that enhance a more enriching and interactive learning experience.

Fourthly, regarding the utility of the chatbot as a support tool in understanding and applying UDL concepts, the results revealed that students perceived the chatbot as a complementary tool. Its ability to provide clear explanations, specific examples, and additional resources significantly contributed to the effective understanding and application of UDL principles. In terms of utility, the positive perception of students reinforces the findings of Cruz et al. (2021), who argue that the perceived utility of technology is essential for its adoption and effectiveness in the educational domain.

Fifthly, university student satisfaction regarding the implementation of the chatbot to enhance learning about UDL is notably positive. The majority of students expressed satisfaction with the experience, emphasizing the convenience, availability, and additional support provided by the chatbot in their learning process.

In conclusion, the virtual chatbot designed, implemented, and evaluated for educational purposes on UDL is not only capable of providing information and/or answers to questions efficiently but can also automate tasks and offer personalized advice and guidance. Therefore, this chatbot directly contributes to the creation of more inclusive and accessible learning environments. Its ability to simulate human conversation not only enhances the student experience but also provides a versatile tool for educational support, enabling the application of personalized strategies aligned with the fundamental principles of UDL. In this regard, the strategic integration of chatbots in educational environments cannot only improve communication efficiency but also enrich the learning experience through adaptability and personalization, which are essential aspects of UDL.

Regarding the limitations of the study, self-perception can be influenced by various factors, including participants' prior expectations and their level of familiarity with similar technologies. Additionally, the sample may not fully represent the diversity of students in university settings and was not randomly selected. Future research could address this limitation by including

more diverse samples and combining quantitative and qualitative data to gain a more comprehensive understanding of the student experience. Moreover, as a research prospect, there is a need to implement its use among other university students, as well as external users.

This study highlights the feasibility and benefits of integrating chatbots in higher education, supporting both accessibility and the effectiveness of inclusive learning, in line with the principles of UDL.

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