

WIP: Investigating the Use of AI Chatbots by Undergraduate Computer Science Students

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Abstract— This work in progress paper investigates the use of AI chatbots by undergraduate computer science students learning English as a second language in Japan. The study employs a mixed-methods approach, combining qualitative surveys and interviews with quantitative clustering analysis. The objectives are to identify the types of AI chatbots used, determine their usage patterns, and explore the benefits and challenges associated with their use in language learning. The qualitative data collection (surveys, $n=96$) has been completed, while interviews and quantitative analysis are ongoing. The study aims to identify distinct clusters of AI chatbot users and their characteristics, highlight challenges, and contribute to the growing knowledge on AI application in STEM students studying a second language. Future research should explore long-term effects, optimal balance between AI-assisted and human-led instruction, and guidelines for integrating AI chatbots in language learning curricula.

Keywords—AI, Chatbots, Learner Analytics, Language Learning, STEM, ESL, EFL

I. INTRODUCTION

This research paper is a work in progress paper that explores the use of AI chatbots by undergraduate computer science students learning English as a second language. The research employs a mixed-methods approach, combining qualitative surveys and interviews with quantitative clustering analysis of the survey data. The primary objectives are to identify the types of AI chatbots used by students, determine when and how they are utilized, and provide insights into the potential benefits and challenges associated with their use in language learning.

The qualitative component of the study involves online surveys and semi-structured interviews with a sample of undergraduate computer science students ($n=96$) from a university in Japan. The surveys gather data on students' demographics, English proficiency, device preference, and experience with AI chatbots.

Since this is a work in progress paper, the qualitative data collection has been completed, but the interviews and quantitative analysis is still in process. The interviews will provide deeper insights into students' motivations, perceptions, and strategies for using AI chatbots in their language learning process.

The quantitative analysis will focus on identifying patterns and clusters within the survey data using multidimensional data analysis techniques. The results may identify distinct clusters of AI chatbot users and their characteristics, which could aid in the design of personalized learning environments. The study will also highlight challenges identified by students,

such as the need for improved conversational abilities of AI chatbots, prompt engineering amongst students, and the importance of dialogic space created with the AI-assisted through human interaction.

This study focuses on Computer Science undergraduates due to their unique position at the intersection of technology and language learning. Their technical background may influence their approach to and adoption of AI chatbots for language learning, potentially offering insights into how STEM students utilize these tools differently from other learners. This perspective is particularly valuable as it may inform the development of AI-assisted language learning tools tailored to the needs and preferences of technically-inclined students.

This research contributes to the growing body of knowledge on the application of AI in STEM students who are also studying a second or foreign language and provides valuable insights for educators, researchers, and developers working in this field. Future research should explore the long-term effects of AI chatbot use on language proficiency, investigate the optimal balance between AI-assisted and human-led instruction, and develop guidelines for effectively integrating AI chatbots in language learning curricula.

II. LITERATURE REVIEW

A. Overview of the Research Area

The rapid advancement of artificial intelligence (AI) technologies has led to the widespread adoption of AI chatbots in various domains, including education. Language learning, in particular, has seen a growing interest in the use of AI chatbots as a tool to support and enhance the learning process. This area of research focuses on investigating the effectiveness, challenges, and potential of AI chatbots in assisting language learners, particularly in the context of learning English as a second language (ESL) or English as a foreign language (EFL).

This study is grounded in the Interactionist Theory of Second Language Acquisition (SLA), which emphasizes the importance of interaction in language learning. Long's Interaction Hypothesis [1] posits that conversational interaction facilitates language acquisition through negotiation of meaning, which aligns with the interactive nature of AI chatbots. Additionally, we draw upon Vygotsky's Sociocultural Theory [2], particularly the concept of the Zone of Proximal Development, to explore how AI chatbots may scaffold language learning experiences.

Recent studies have explored the use of AI chatbots in language learning from different perspectives, such as their

impact on learners' motivation, engagement, and language proficiency. Some studies have highlighted the benefits of AI chatbots, such as providing learners with instant feedback, personalized practice, and increased exposure to authentic language use. Others have identified challenges, such as the limitations of AI chatbots in understanding context, providing accurate feedback, and fostering critical thinking skills. The current research landscape in this area includes studies on the perceptions and experiences of language learners and teachers using AI chatbots, the design and development of AI chatbots specifically tailored for language learning, and the integration of AI chatbots into existing language learning curricula. As the field continues to evolve, there is a growing need for empirical evidence to support the effective use of AI chatbots in language learning and to address the challenges and concerns associated with their implementation. Our study aims to bridge this gap by investigating the chatbot usage patterns, preferences, and challenges specific to Computer Science undergraduates learning English as a second language.

B. AI Chatbots in Language Learning

The rapid advancement of artificial intelligence (AI) technologies has led to the widespread adoption of AI chatbots in various domains, including education. Language learning [3, 4], in particular, has seen a growing interest in the use of AI chatbots as a tool to support and enhance the learning process. This literature review explores the current state of research on the use of AI chatbots in language learning, focusing on their effectiveness, challenges, and potential, particularly in the context of learning English as a second language (ESL) or English as a foreign language (EFL).

The use of AI chatbots in language learning has been a topic of interest for researchers in recent years. Early studies, such as Fryer and Carpenter[5], explored the potential of chatbots as language learning tools, discussing their advantages and limitations. Jia [6] presented the development and evaluation of an AI chatbot specifically designed for English language learning, demonstrating the effectiveness of using Natural Language Processing (NLP) techniques and knowledge-based reasoning to create an interactive language learning tool.

NLP techniques have played a crucial role in the development of AI chatbots for language learning. Coniam [7] evaluated the linguistic accuracy of chatbots from an ESL perspective, highlighting the importance of assessing the quality of chatbot responses for language learning purposes and providing recommendations for improving their usability. Shawar and Atwell [8] investigated the usefulness of chatbots in various domains, including language learning, discussing the potential benefits and challenges of using chatbots and providing insights into their design and evaluation.

AI chatbots fall under the broader category of Computer-Assisted Language Learning (CALL) tools. Winkler and Söllner [9] conducted a comprehensive review analyzing the current state of chatbots in education, including their use in language learning. They identified key research gaps and provided recommendations for future research and practice. The integration of AI chatbots into existing CALL frameworks and language learning curricula is an area that requires further investigation.

The use of AI chatbots in language learning can be informed by Second Language Acquisition (SLA) theories.

Fryer et al. [10] compared the effectiveness of chatbots and human task partners in stimulating and sustaining learners' interest in a language course, providing empirical evidence on the motivational benefits of using chatbots in language learning. Huang et al. [11] investigated the impact of using a chatbot on EFL learners' speaking anxiety and oral performance, highlighting the potential of chatbots to provide a low-anxiety environment for language practice and improvement.

AI chatbots have the potential to provide personalized and adaptive learning experiences for language learners[12]. Understanding learner perceptions and attitudes towards AI chatbots is crucial for their effective implementation in language learning[13]. The design and development of AI chatbots specifically tailored for language learning is an active area of research[14]. Evaluating the effectiveness of AI chatbots in language learning contexts is essential for their continued improvement and widespread adoption[15, 16].

C. Ethical Considerations in the Use of AI in Education

As the use of AI in education, including language learning, continues to grow, it is crucial to consider the ethical implications of these technologies[17, 18]. The current study addresses this by adhering to ethical guidelines for research involving human participants, ensuring the anonymity and confidentiality of participants' responses, and obtaining approval from participants. Future research should continue to explore the ethical considerations surrounding the use of AI chatbots in language learning and develop guidelines for their responsible implementation.

This literature review highlights the growing body of research on the use of AI chatbots in language learning, covering topics such as NLP techniques, CALL, SLA theories, personalized and adaptive learning, learner perceptions, design and development, evaluation, and ethical considerations.

D. Importance of the Research and its Contribution

This research is crucial for several reasons. First, it addresses the growing demand for innovative and effective language learning tools in an increasingly globalized world. As English continues to be the lingua franca of international communication, business, and academia, the need for accessible and efficient language learning solutions has never been greater. AI chatbots have the potential to provide learners with personalized, interactive, and flexible learning experiences, which can complement traditional classroom instruction and support self-directed learning.

Second, this research contributes to the understanding of how AI technologies can be leveraged to support language learning, particularly for learners with diverse backgrounds and needs. By focusing on undergraduate computer science students learning English as a second language, this study provides insights into the specific challenges and opportunities of using AI chatbots in a STEM education context. The findings can inform the design and development of AI chatbots that cater to the needs of learners with technical backgrounds and help bridge the gap between language learning and domain-specific knowledge.

Third, the mixed-methods approach employed in this study allows for a comprehensive understanding of the phenomenon, combining the depth of qualitative insights with the generalizability of quantitative findings. The use of

unsupervised machine learning techniques for clustering analysis is a novel contribution to the field, as it enables the identification of distinct patterns and profiles of AI chatbot users, which can inform the personalization of language learning experiences.

Finally, this research contributes to the broader discourse on the role of AI in education and its potential to transform the way we teach and learn languages. By providing empirical evidence on the benefits and challenges of using AI chatbots in language learning, this study can inform the development of best practices, guidelines, and policies for the responsible and effective integration of AI technologies in educational settings.

III. METHODOLOGY

A. Approach

This study employs a mixed-methods approach, combining qualitative surveys and interviews with quantitative clustering analysis of the survey data to investigate the use of AI chatbots by undergraduate computer science students learning English as a second language. The participants in this study are undergraduate computer science students (n=96) from a university in Japan. The sample is diverse in terms of age, gender, and English proficiency levels to ensure a comprehensive representation of the target population.

B. Data collection

The data collection process involves two main components: online surveys and semi-structured interviews. The online surveys are designed to gather data on students' demographics, English proficiency, device preference, and experience with AI chatbots. The survey questionnaire (see attached document) consists of 12 questions, including multiple-choice and open-ended questions. The questionnaire is available in both English and Japanese to ensure clarity and accessibility for all participants.

Semi-structured Interviews: Participants who express their willingness to provide more detailed insights into their experience with AI chatbots for language learning are invited to participate in semi-structured interviews. The interviews are conducted to gain a deeper understanding of students' motivations, perceptions, and strategies for using AI chatbots in their language learning process.

C. Data analysis

The data analysis for this study involves both qualitative and quantitative methods. **Qualitative Analysis:** The responses to open-ended survey questions and the transcripts of semi-structured interviews are analyzed using thematic analysis. This process involves identifying, analyzing, and reporting patterns or themes within the data. The analysis focuses on understanding students' experiences, challenges, and strategies related to using AI chatbots for language learning.

Quantitative Analysis: The quantitative analysis focuses on identifying patterns and clusters within the survey data using unsupervised machine learning techniques. The survey responses are preprocessed and transformed into a suitable format for clustering algorithms, such as K-means or hierarchical clustering. The optimal number of clusters is determined using evaluation metrics like the silhouette score or the elbow method. The resulting clusters are then analyzed

to identify distinct groups of AI chatbot users and their characteristics..

D. Ethical considerations and limitations

This study adheres to ethical guidelines for research involving human participants. All participants are informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time. The anonymity and confidentiality of participants' responses are maintained throughout the research process.

IV. RESULTS: QUALITATIVE

The following section presents the results of a thematic analysis conducted on the open-ended survey responses regarding the students' desired future AI-assisted language learning tools. This open-ended question, aimed to gather insights into their aspirations and expectations for the integration of advanced AI technologies in their language learning processes.

To ensure clarity and address potential translation issues, both the English and Japanese versions of the responses are included where applicable. This bilingual approach not only respects the linguistic diversity of the respondents but also aids in accurately conveying the nuances of their feedback.

The themes identified from the responses highlight key areas where students see the potential for AI to significantly enhance their language learning experiences. The open-ended responses to the survey question regarding desired future AI-assisted language learning tools were categorized into three primary themes: AI as a conversational partner, real-time translation and interpretation, and enhanced natural language interaction.

A. AI as a Conversational Partner

This theme emerged 73 times, indicating a significant interest in using AI to simulate human interactions for practicing natural English. Respondents emphasized the need for AI to act as a conversational partner, enabling more natural and spontaneous dialogues.

Examples include:

- "AI friend."
- "Practice Talking natural English."
- "A machine can communicate such as a real person."
- Learning that allows free conversation and simulates a real speaking partner in front of you ("自由に会話できて AI によって目の前に実際に口を動かしている会話相手がいるような学習。")

B. Real-Time Translation and Interpretation

This theme was mentioned 12 times, reflecting a strong interest in advanced real-time translation tools that provide instantaneous and accurate translations. Respondents highlighted the importance of tools that can translate spoken and written language in real-time, enhancing their language learning experience.

Examples of responses:

- Earphones with real-time translation feature ("リアルタイム翻訳機能つきイヤホン")
- Tools that can translate what you see ("目で見たものを翻訳できるツール")
- Tools that can translate instantly and systems that provide perfect translations ("一瞬で翻訳するツール、完璧に翻訳するシステム")
- "Avoid literal translations of popular words and phrases."

C. Enhanced Natural Language Interaction

This theme appeared 4 times, underscoring the desire for more natural and fluid interactions with AI. Respondents expressed a need for AI technologies that make conversations feel more human-like and less mechanical.

Response examples:

- "AI とナチュラルな英会話ができること" (Being able to have natural English conversations with AI)
- "自然な英会話を練習すること" (Practicing natural English conversation)

The thematic analysis of the open-ended responses reveals that students have high expectations for the future of AI in language learning. They envision AI technologies that can serve as conversational partners, provide real-time translation and interpretation, and facilitate more natural language interactions. These findings suggest a strong demand for advancements in AI that can make language learning more interactive, accurate, and human-like.

V. RESULTS: QUANTITATIVE

This section presents the quantitative analysis of survey data collected from students regarding their demographics, device usage for language learning, and experiences with AI chatbots. The analysis aims to identify significant patterns and trends that can inform the development of future AI-assisted language learning tools.

How often do you use AI chatbots for language learning? 言語学習にAIチャットボットをどのくらいの頻度で使っていますか?
96 responses

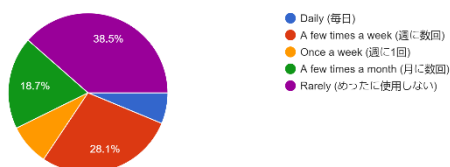


Figure 1: Frequency of Chatbot use for language learning.

The results presented here are preliminary findings based on descriptive statistics and initial thematic analysis. More advanced quantitative analyses, including the clustering analysis described in the Methodology section, will be conducted as the study progresses. These analyses will provide deeper insights into usage patterns and user profiles, complementing the current descriptive statistics.

The survey data reveals that the majority of respondents are aged 18-20 (85 participants), with smaller groups aged 21-23 (9 participants), over 26 (1 participant), and under 18 (1 participant). The gender distribution shows a predominance of male respondents (81), with fewer female respondents (12) and a small number preferring not to disclose their gender (3). In terms of English proficiency, most respondents identify as either intermediate (51) or beginner (44), with only one respondent at an advanced level.

Regarding device usage for language learning, smartphones are the most used device (80 instances), followed by laptops (71 instances). Desktops and tablets are used less frequently, with 28 and 20 instances respectively, and textbooks are rarely used (1 instance). AI chatbot usage is high, with 79 respondents using them for language learning and 17 not using them. These insights highlight the current landscape and future needs in AI-assisted language learning.

Out of 96 respondents, 79 have used AI chatbots, indicating a high level of engagement with this technology. When asked for information on the specific AI chatbots respondents have used, respondents could select multiple options, and the most frequently mentioned chatbots included ChatGPT (72), Duolingo (27), Gemini (8), and specific language learning chatbots integrated into educational platforms like Weblia (1). This data helps in understanding which tools are popular and widely adopted among students.

The frequency of AI chatbot usage among respondents is shown in Fig. 1. The frequency of use varies, with 6 students using them daily, 27 a few times a week, 8 once a week, 18 once a month, and 37 rarely. This distribution provides insights into how integral these tools are to the students' learning routines. Even though 82.3% reported using AI for language learning, 38.5% of those reported rarely using it, but due to the design of the question, this includes the students who do not use AI. If we exclude the 17.7% that do not use AI, the rarely used percentage is closer to 20%. However, this will need to be investigated in more detail to get an accurate number.

Responses concerning the different purposes for which students use AI chatbots. Common uses include practicing vocabulary (43), Grammar practice (43), writing practice (32), and pronunciation (11), conversation (15). When asked to assess the perceived effectiveness of AI chatbots, responses vary from highly effective to not effective at all. Specifically, 22 students rated them as very effective, 39 as effective, 25 as somewhat effective, and 9 as not very effective, and 1 as very ineffective. The majority of students find AI chatbots to be moderately to highly effective, indicating general satisfaction with their impact on language learning.

Students were asked to identify the challenges students face when using AI chatbots. Common issues include lack of natural conversation (39), difficulty in prompt formation (37), lack of personalization (16), and technical issues (18). Understanding these challenges is crucial for improving the design and functionality of AI chatbots to better serve educational purposes. This information is valuable for developers and educators looking to enhance AI chatbot technologies for educational use.

Our results indicate that a significant portion of students (57%) use chatbots once a month or less, including those who have never used them. This finding highlights the need to investigate barriers to adoption and factors influencing usage

frequency. Future research should explore why some students are not engaging with these tools regularly and how to increase meaningful engagement.

VI. NEXT STAGE OF RESEARCH

As a work in progress, the qualitative data collection through surveys has been completed, and the next steps involve conducting interviews and performing quantitative analysis. The interviews aim to provide a deeper understanding of students' motivations, perceptions, and strategies for using AI chatbots in their language learning process, which will complement the survey data.

The quantitative analysis will employ multidimensional data analysis techniques to identify patterns and clusters within the survey data. This analysis is motivated by the potential to identify distinct groups of AI chatbot users and their characteristics, which could inform the design of personalized learning environments tailored to specific user profiles. Additionally, the study will highlight challenges already identified by students, such as the need for improved conversational abilities of AI chatbots, the importance of prompt engineering among students, and the role of dialogic space created through the combination of AI-assisted and human interaction.

The motivation behind this research lies in its contribution to the growing body of knowledge on the application of AI in the context of STEM students who are simultaneously learning a second or foreign language. The findings will provide valuable insights for educators, researchers, and developers working in this field, enabling them to better understand and address the needs of this specific student population.

To further advance this research area, future studies should focus on investigating the long-term effects of AI chatbot use on language proficiency, determining the optimal balance between AI-assisted and human-led instruction, and developing guidelines for effectively integrating AI chatbots into language learning curricula. These future research directions will help to maximize the benefits of AI chatbots in language learning while minimizing potential challenges and ensuring the most effective integration of this technology in educational settings.

VII. CONCLUSION

This study contributes to the growing body of knowledge on AI-assisted language learning by focusing specifically on Computer Science undergraduates, a population at the intersection of technology and language education. Our findings provide insights into the types of chatbots used, usage patterns, and perceived benefits and challenges among this group. These insights can inform the development of tailored AI-assisted language learning tools and strategies for STEM students. Furthermore, by exploring the unique perspective of technically-inclined learners, this research opens new avenues for investigation in the field of engineering and computing education, particularly in how technical knowledge influences the adoption and use of AI tools for language learning.

The qualitative analysis of open-ended survey responses has revealed students' aspirations for future AI-assisted language learning tools, highlighting the potential for AI to enhance language learning experiences and suggest areas for future development. The quantitative analysis of survey data has identified significant patterns and trends in students'

demographics, device usage, and experiences with AI chatbots, showing a high level of engagement with ChatGPT being the most widely used. Students find these tools moderately to highly effective for practicing vocabulary, grammar, writing, and conversation, despite challenges such as lack of natural conversation and personalization.

The next stage of this research involves conducting interviews and employing multidimensional data analysis techniques to gain deeper insights into students' motivations, perceptions, and strategies, potentially informing the design of personalized learning environments. This research contributes to the growing knowledge on the application of AI in the context of STEM students learning a second or foreign language, providing valuable insights for educators, researchers, and developers. Future research should focus on investigating the long-term effects of AI chatbot use, determining the optimal balance between AI-assisted and human-led instruction, and developing guidelines for effective integration of AI chatbots into language learning curricula.

In conclusion, this study has demonstrated the potential of AI chatbots in supporting language learning for undergraduate computer science students and identified key areas for future development and research, highlighting the importance of harnessing AI's potential while addressing challenges and ensuring effective integration in educational settings.

A. Limitations

The limitations of this study include the relatively small sample size and the focus on a specific population (undergraduate computer science students in Japan). Future research should explore the use of AI chatbots for language learning in different educational contexts and with larger, more diverse samples. Additionally, longitudinal studies can provide insights into the long-term effects of AI chatbot use on language proficiency. Further research should also investigate the optimal balance between AI-assisted and human-led instruction and develop guidelines for effectively integrating AI chatbots in language learning curricula. Also, the current analysis is based on survey data only, and future incorporation of interview data may yield additional insights. Lastly, the rapid evolution of AI chatbot technology means that usage patterns and perceptions may change quickly, necessitating ongoing research in this area.

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