

Applying a Large Language Model to Second Language Acquisition

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Second language acquisition (SLA) stands as a pivotal domain in fostering cross-cultural communication and expanding social networks. In this paper, we propose an innovative study on SLA that leverages sound sensors and transducers. The interactions between speaking and listening play a crucial role in the process of SLA. However, the integration of real-time interaction practices within SLA classrooms poses challenges because of constraints on educator availability and instruction efficacy. To address this issue, in this study, we evaluate the accessibility and effectiveness of a large language model (LLM)-based chatbot as a supplementary tool in facilitating one-on-one real-time interaction practices online. The research focuses on learners engaged in the acquisition of Chinese as a second or foreign language. Our findings underscore the need for enhancements in the design and functionality of the LLM-based chatbot specifically tailored to the objectives of SLA. Additionally, insights garnered from the analysis contribute to discussions surrounding the integration of technology, such as Copilot, as adjunctive aids in language education, particularly within the framework of SLA. In our future research endeavors, we will delve into a comprehensive analysis to identify factors influencing the availability and effectiveness of the chatbot. In this research, we advance technological solutions in language education to enhance interaction and improve SLA outcomes.

1. Introduction

In recent decades, the rapid progression of semiconductor fabrication has emerged as a cornerstone in driving the rapid evolution of information and communication technologies. These technological advancements have brought about profound global transformations, exerting a notable impact on the human condition. The theory of “orange technology”⁽¹⁾ posits that

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technological advancements should be oriented towards augmenting human well-being. Among the multifaceted determinants influencing the human pursuit of well-being, education emerges as particularly influential. Through educational endeavors, individuals gain proficiency, elevate their socioeconomic standings, and cultivate greater contentment in their lives. Consequently, a key focus within the realm of orange technology pertains to the enhancement of learning efficacy and efficiency through modern technological tools.

The advancement of semiconductor technology has significantly driven the development of sensor technology, leading to its widespread adoption across various domains, including education. In recent years, sensors have been increasingly utilized in diverse learning contexts, such as classroom management and e-learning. In this paper, we propose an innovative study on second language acquisition (SLA) utilizing sound sensors and transducers. Speaking and listening interactions are essential in SLA, and large language models (LLMs) can facilitate these interactions directly with students. Human-machine interactions leverage microphones, speakers, and speech-to-text and text-to-speech technologies.

SLA, a field that has emerged and matured considerably over the last fifty years, represents a specialized area of inquiry within linguistics and education.^(2,3) In this field, the intricate and multifaceted processes involved in the efforts of learners to acquire proficiency in a second language (L2) are investigated. Through extensive research and theoretical advancements, SLA has evolved into a comprehensive field of study, encompassing various factors such as linguistic, cognitive, social, and psychological aspects of language learning.^(4,5) The study of SLA holds considerable significance in fostering effective cross-cultural communication among individuals from diverse cultural backgrounds. Moreover, at the individual level, the mastery of an L2 yields noteworthy efficacy in significantly broadening one's social networks. This expansion of social connectivity underscores the inherent value of SLA in facilitating intercultural interactions and promoting global understanding.

Active engagement in L2 practice surfaces as a requisite for learners endeavoring to attain linguistic proficiency across various skill domains encompassing listening, reading, speaking, and writing. Diligent involvement in practicing a designated L2 manifests a discernible enhancement in vocabulary acquisition and fosters a deeper comprehension of grammatical frameworks. Furthermore, the pragmatic application of an L2 functions as a pivotal conduit, adeptly bridging the dichotomy between conventional classroom-based instructional methodologies and genuine communicative settings in the real world.^(6,7)

Current learning resources often fall short, particularly in facilitating real-time interactive practices within the realm of SLA. Real-time interactions play a pivotal role in directly enhancing comprehension and expressive abilities. Traditionally, such interactive practices have heavily leaned on the active involvement of instructors and teaching assistants. However, the evident disparity between student enrollment and the availability of teaching personnel underscores a palpable inadequacy in sustaining real-time interactive practices within conventional classroom settings.

Tailored instruction, although proven effective, frequently encounters financial and logistical challenges, impeding its widespread implementation. Therefore, the utilization of contemporary technologies to enable real-time interactive practices in SLA arises as a feasible and pragmatic solution.

In this paper, we introduce a research proposal aimed at evaluating the accessibility and efficacy of generative AI in SLA, specifically focusing on the acquisition of the Chinese language by non-native speakers. The research design entails a practical scenario where students actively participate in real-time interaction exercises by engaging in dialogue with Copilot, a chatbot utilizing the LLM developed by Microsoft. Following their interactive sessions with Copilot, participants underwent a survey designed to systematically assess the accessibility and effectiveness of this AI application. The data collected from the survey were analyzed using the framework of the technology acceptance model (TAM).

The subsequent sections of this paper follow a structured format as delineated below. In Sect. 2, we comprehensively review related literature. In Sect. 3, a succinct introduction is provided regarding our application scenario and experimental methodology. In Sect. 4, we delve into the analysis and discussion of experimental findings. Lastly, in Sect. 5, we present the conclusions of this study.

2. Related Works

A chatbot, also referred to as a chatterbot, denotes a software application designed to engage in conversations with individuals through text or voice interactions.⁽⁸⁾ Chatbots typically interface through various mediums, such as text terminals, web chatboxes, and mobile applications. Users, whether testers or testees, can input messages to the chatbot, eliciting responses based on prebuilt understanding and decision-making mechanisms, as depicted in Fig. 1. The efficacy of these responses hinges upon predetermined mechanisms adept at addressing fixed-format queries promptly and accurately. Moreover, contemporary chatbots, integrated with natural language processing models, can accurately respond to more intricate inquiries.⁽⁹⁾

Chatbots, a manifestation of advancements in AI, serve as technological tools designed to confront the Turing Test—a seminal benchmark devised to evaluate the capacity of AI to exhibit conversational behavior resembling that of humans.⁽¹⁰⁾ Notably, Eliza emerges as one of the earliest instances of a chatbot implementing a pattern-matching and substitution methodology.^(11,12) The subsequently developed ALICE, which stands for Artificial Linguistic Internet Computer Entity, is a natural language processing AI chatbot program created by Dr. Richard Wallace in the mid-1990s. ALICE was designed to engage in text-based conversations with users

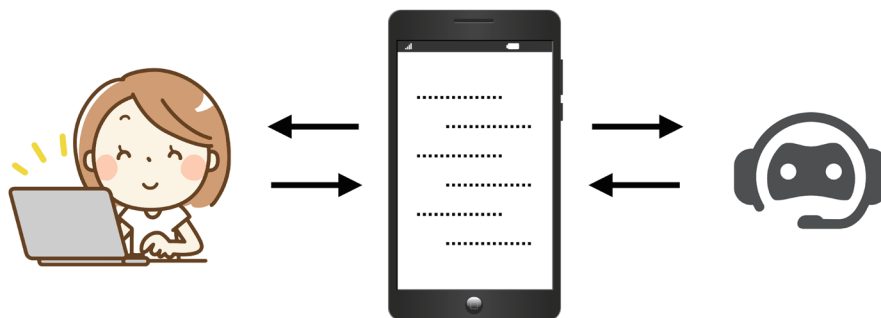


Fig. 1. (Color online) Operation of the chatbot.

and simulate human-like interactions. It gained popularity as one of the earliest examples of chatbot technology and has been utilized in various applications, including language learning, customer service, and entertainment.⁽¹³⁾

However, owing to limitations in hardware capabilities during its inception, early iterations of chatbots, such as Eliza and ALICE,^(1,14) heavily relied on rule-based programming techniques aimed primarily at challenging the Turing Test. Consequently, the efficacy of these early chatbots remained inherently constrained within the realm of AI development.

A significant paradigm shift in chatbot development was catalyzed by the widespread proliferation of social media and e-commerce platforms on the Internet. Initially conceived to facilitate human interactions online, chatbots were designed to serve both social and commercial purposes. These early chatbots primarily operated within specific domains, notably focusing on enhancing customer service experiences. In contemporary contexts, human agents predominantly oversee customer service operations across diverse e-commerce platforms, exemplified by entities such as Amazon and Alibaba, with supplementary assistance provided by chatbots. Furthermore, developers leverage comprehensive toolsets, such as *api.ai* and *wit.ai*,^(15,16) to expedite the creation of tailored chatbot solutions, thereby empowering businesses to swiftly deploy customized chatbot functionalities.⁽¹⁷⁾

The subsequent significant progression in chatbot advancement occurred with the notable rise of deep learning methodologies over the past decade, facilitated by the extensive accumulation of data made possible by the Internet and the computational capabilities offered by Graphics Processing Units. Consequently, leveraging pretrained LLMs can augment chatbots to furnish high-quality responses to complex queries across general domains.⁽¹⁸⁾ In the winter of 2022, OpenAI unveiled ChatGPT, a chatbot model that garnered considerable success across diverse business sectors and domains.⁽¹⁹⁾ Subsequently, in February 2023, Microsoft introduced Copilot, harnessing its proprietary LLM, and seamlessly integrated it into the Bing search engine.⁽²⁰⁾ Copilot exhibits versatility in addressing inquiries spanning various domains without necessitating a specific format, emulating natural human conversation, and autonomously generating realistic responses. Given its accessibility and capabilities, Copilot was selected as the platform for conducting real-time interaction practices in SLA in this study.

The TAM crafted by Fred Davis in the 1980s⁽²¹⁾ stands as a seminal theoretical construct designed to elucidate the intricacies underlying users' adoption and utilization of technology. As illustrated in Fig. 2, TAM shows in detail its constituent components and the intricate interplay among them. Central to TAM is the proposition that two fundamental beliefs, namely, perceived usefulness (PU) and perceived ease of use (PE), exert substantial influence over the acceptance behaviors of individuals towards computer systems. These foundational beliefs serve as pivotal determinants, shaping the attitudes of users toward technology adoption and ultimately influencing their usage behaviors.

PU delineates the extent to which an individual perceives that the adoption of a particular system would enhance their job performance, whereas PE encompasses the degree to which an individual views the utilization of the said system as effortless. Within the TAM framework, these two core beliefs collaboratively inform the overall attitude towards the system adoption of an individual. Consequently, these attitudes subsequently shape the intention of an individual to employ the system and ultimately dictate their actual usage behavior. This intricate interplay

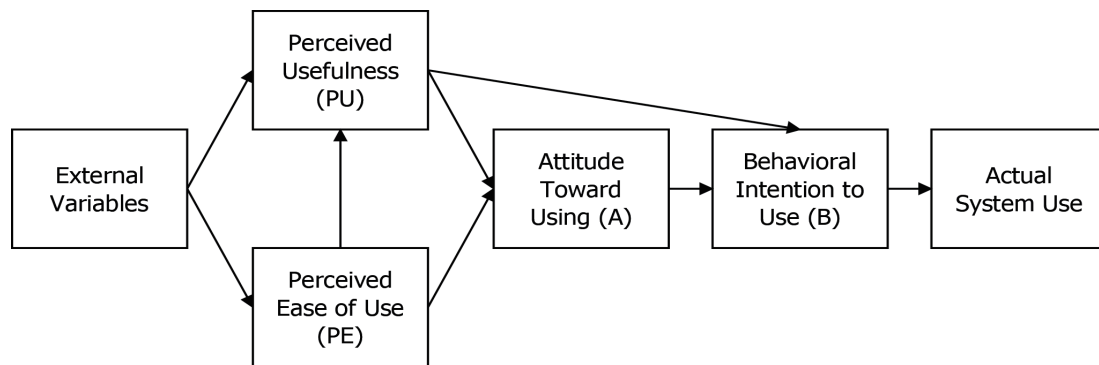


Fig. 2. TAM.

among PU, PE, and attitudes of users underscores the nuanced dynamics inherent in technology adoption processes.

Renowned for its widespread application and empirical validation across diverse contexts, TAM has undergone refinements and extensions, exemplified by TAM2⁽²²⁾ and the Unified Theory of Acceptance and Use of Technology⁽²³⁾. Despite these developments, TAM remains a cornerstone in the field of information systems research, maintaining its status as one of the most influential models. Its enduring relevance lies in its capacity to elucidate the intricate processes involved in the adoption and utilization of emerging technologies, spanning both organizational and consumer domains.

3. Design of Experiment

In the conventional instructional framework facilitating real-time interaction practices within an L2 classroom, the instructor traditionally operates within the confines of assisting individual students, necessitating one-on-one, face-to-face engagement. This approach is constrained by two salient factors. Primarily, it mandates the simultaneous physical proximity of both the teacher and the student. Nonetheless, this limitation can be mitigated through the adoption of online platforms for instructional meetings. The integration of online real-time interaction transcends spatial limitations, enabling an extended duration of engagement between the teacher and the student, as it eliminates the necessity for commuting time.

Furthermore, the existing teaching resources are insufficient to meet the real-time interaction requirements of all students. Modern chatbots based on LLMs, such as ChatGPT and Copilot, demonstrate the capability to emulate human conversation to a considerable degree. Employing LLM-based chatbots as a substitute for conducting one-on-one real-time interaction practices online presents non-native Chinese students with expanded opportunities for interaction practice. However, before integrating chatbots into L2 classes, two critical issues warrant exploration.

- Students are required to acknowledge and embrace the utilization of LLM-based chatbots, which serve as a partial surrogate for the instructional role conventionally fulfilled by teachers or teaching assistants during interactive practice sessions.

- Engaging in interactive practices facilitated by LLM-based chatbots enables students to augment their proficiency in Chinese language acquisition.

In the preliminary survey, a comprehensive set of 23 items was employed to evaluate effectiveness and accessibility during the pretest phase. After item analysis, six items displaying comparatively low reliability were excluded from the questionnaire. Consequently, a questionnaire with a reliability coefficient of Cronbach's Alpha 0.967 was obtained, meeting the requisite standards of content validity as assessed by experts in the domains of teaching Chinese as an L2, teaching English to speakers of other languages, education science, and computer science.

The experimental flow is illustrated in Fig. 3. To evaluate both the acceptance and efficacy of the experimental design, an authentic one-on-one real-time interaction session was conducted online, as depicted in Figs. 4(a)–4(c). This session, conducted via the Edge browser and lasting approximately 20 min, involved participants interacting with Copilot by responding to a minimum of ten questions. After the interactive practice, participants were administered a questionnaire, available in both traditional and simplified Chinese versions, tailored to their

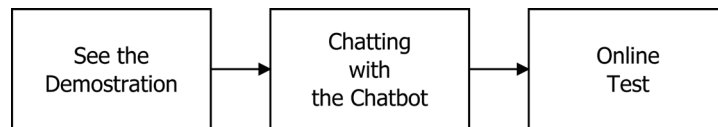


Fig. 3. Experimental flow.

The dialogue between one student and Copilot is as below:

“You” asked the question, “What are the special snacks in Fuzhou?” Copilot showed “Answers are being generated for you...” first, and then replied as follows:

There are many delicious specialty snacks in Fuzhou that you should definitely try! Here are some of Fuzhou’s traditional snacks:

1. **Fish balls:** Characterized by having fillings, good taste, nicely bouncy, no deterioration after long-term cooking, elasticity, and delicious taste.
2. **Meat Swallow:** It is also known as Taiping Swallow. The swallow skin is as thin as white paper. The taste is soft and tender, firm and chewy. It is a must-eat snack for Fuzhou people during the New Year’s Festival.
3. **Pot-side paste:** Rice is the main ingredient. Squid whiskers and lean meat are auxiliary materials. The soup is clear and is not thick; the food is delicate and smooth, fragrant and delicious.
4. **Lychee flesh:** It has a history of two or three hundred years because the raw materials include white water chestnuts and pork scored with a crosshatch pattern, which appear like lychees after cooking. The taste is sweet and sour and delicious.
5. **Laohua:** It is also called Lao rice noodles, a famous snack in Fuzhou. Rice noodles are delicate and soft, cooking instantly when lifted out, so they are commonly known as “Lao Xinghua”.

(a)

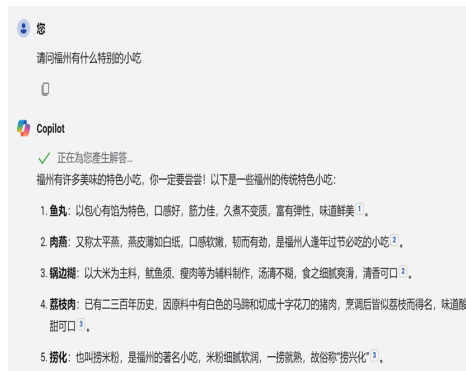


Fig. 4. (Color online) Examples of real-time interactions.



The dialogue between another student and Copilot is as stated below:

After “You” keyed in the question: “Where is it fun in Fuzhou”, Copilot replied as mentioned below.

(Answers are being generated for you...)

There are many interesting attractions in Fuzhou. You must not miss them! Here are some places worth visiting:

1. **Three Lanes and Seven Alleys**: This is the most famous historical and cultural district in Fuzhou, with more than 270 ancient houses, including Yijin Fang, Wenru Fang, and Guanglu Fang.
2. **Drum Mountain**: This mountain is magnificent and quiet, and you can overlook the beautiful scenery of the entire urban area of Fuzhou from the top of the mountain.
3. **Fuzhou West Lake Park**: This is the most well-preserved classical garden in Fuzhou and is worth a visit.
4. **Fuzhou National Forest Park**: Known as one of the top ten forest parks in the country, the park is surrounded by green mountains and has a high content of negative oxygen ions.
5. **Pingtian Island**: The sixth largest island in China, with beautiful scenery such as the Longfengtou Beach and Thirty-six Foot Lake.

Each of these attractions has its own characteristics, so you can choose to visit according to your interests!

(b)

The dialogue between another student and Copilot is listed below.

(You)

I am Vietnamese. Can I get a visa to Taiwan in China?

(Copilot)

(Answers are being generated for you...)

According to the current regulations, Taiwan is a unilateral visa-free country for Vietnam, so when Vietnamese residents enter Taiwan, they do not need to apply for a Taiwan visa. However, it should be noted that a bilateral agreement between Vietnam and Taiwan on visa-free access to citizens of both countries has not yet been reached. Therefore, if you want to travel to Taiwan, you still need to apply for a Taiwan visa.

In addition, it is worth mentioning that the only visa exemption for Vietnam came into effect on March 1, 2015 for members of the flight crew of the China National Aviation Corporation (CNAC). So, if you are a crew member of the CNAC, you can enjoy visa-free treatment.

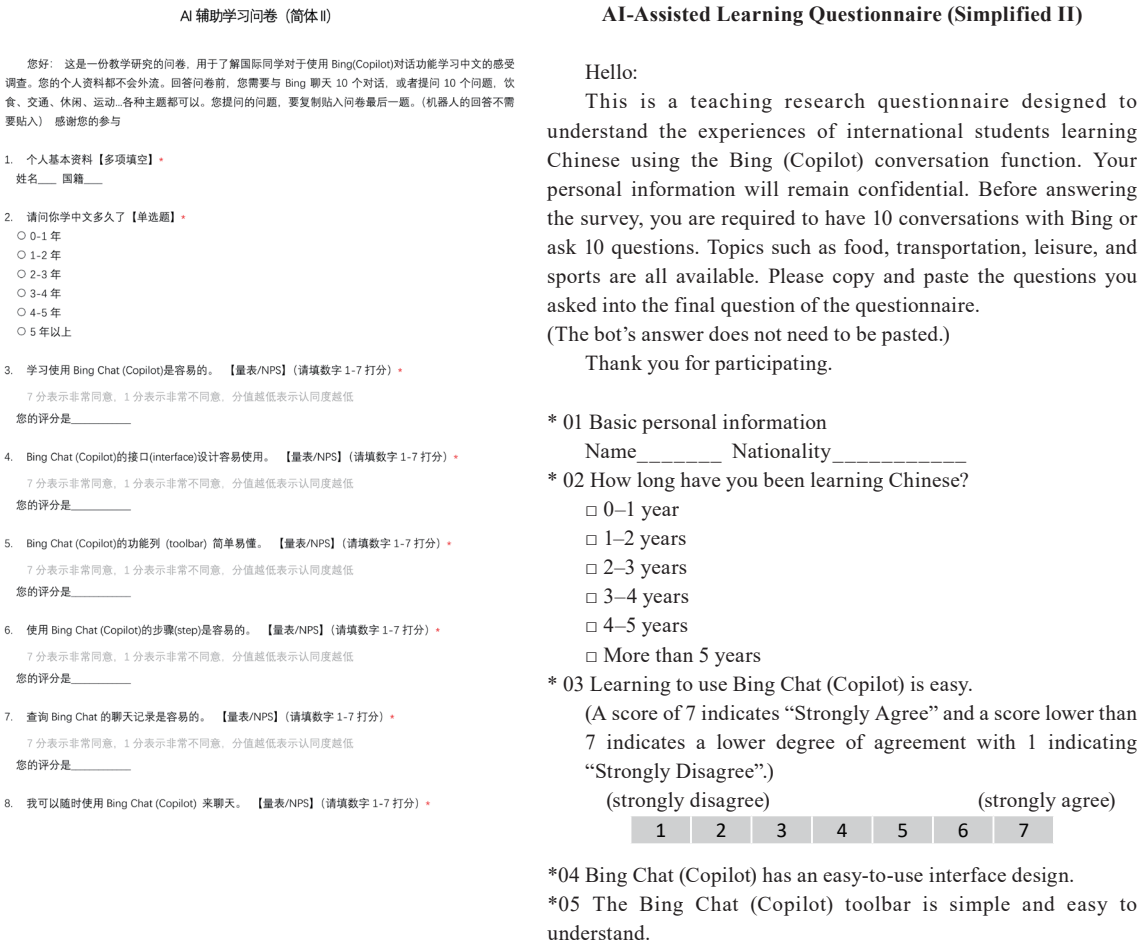
If you plan to travel to Taiwan, it is recommended that you check the specific requirements for a Taiwan visa in advance, and check with Taiwan’s overseas embassies and consulates or representative offices for the latest entry policies. Have a great trip!

(c)

Fig. 4. (Continued) (Color online) Examples of real-time interactions.

respective learning contexts to assess their acceptance levels. The questionnaire, characterized by a high reliability coefficient of 0.967, was designed and administered through the online platform <https://wj.qq.com>, as illustrated in Fig. 5.

The data encompassing responses from 36 foreign students were collected to evaluate both the acceptance and learning efficacy of the participants. These responses were elicited using 17



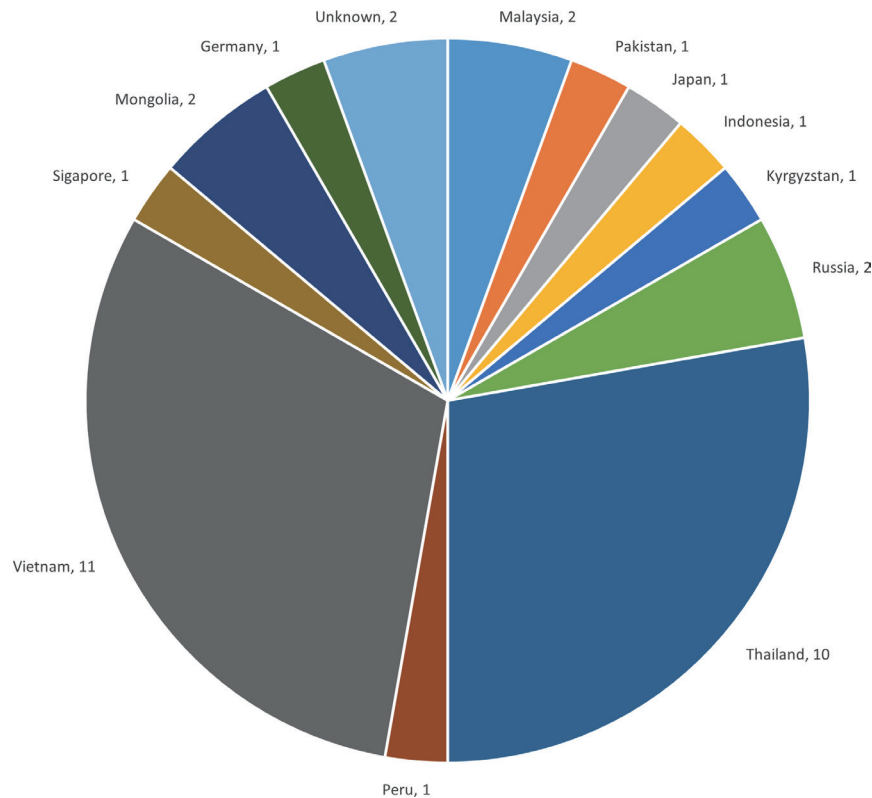


Fig. 6. (Color online) Geographic distribution of participants.

Peru. These participants currently comprise foreign students enrolled in universities situated in China and Taiwan. Unfortunately, two participants carelessly gave the wrong replies answering their nationalities leading to an “unknown, 2” label.

Upon analyzing the survey responses, the 17 questionnaire items underwent categorization into two discrete components: availability and efficacy. The initial eight items, ranging from questions 1 to 8, were deemed indicative of availability, whereas the subsequent nine items, from questions 9 to 17, were identified as relevant to efficacy (see Table 1 for details).

Principal-components analysis was utilized to delineate major factors within the construct, with a threshold of $\lambda > 1$ being applied. Two factors were identified in this analysis that collectively accounted for 73.45% of the observed variance (see Table 2). Subsequently, the oblique rotation method, employing Kaiser’s normalization, was applied to facilitate interpretation. The first factor, encompassing descriptors such as “easy to follow”, “easy to review”, “positive experience of using Copilot”, and similar terms, was designated as availability, signifying PE. Conversely, the second factor, characterized by terms such as “helpful for”, “beneficial for”, “being able to enhance Chinese learning”, and comparable expressions, was labeled as efficacy, corresponding to PU in accordance with TAM.

The conclusive findings delineated in Table 3 underscore the notably high mean scores observed for both efficacy and availability, thereby providing unequivocal support for the proposed alternative. The utilization of the LLM-based chatbot as a partial substitute for

Table 1
Structure matrix.

Items	Components	
	1	2
Q1 The steps for using Copilot are easy to follow.	.811	.631
Q2 It is easy to review the chat records in Copilot.	.865	.646
Q3 I can use Copilot to chat when it is available.	.832	.625
Q4 I can learn Chinese through the responses from Copilot.	.847	.798
Q5 I have had a positive experience using Copilot.	.863	.636
Q6 I enjoy using Copilot.	.859	.685
Q7 I tried to use every function of Copilot.	.803	.748
Q8 Overall, my experience with Copilot has been satisfying.	.867	.625
Q9 I can learn Chinese using Copilot.	.695	.868
Q10 Chatting with Copilot is helpful for my Chinese way of thinking.	.711	.773
Q11 Chatting with Copilot is beneficial for improving my Chinese speaking and writing skills.	.719	.902
Q12 I feel that chatting with Copilot is beneficial for my Chinese learning.	.594	.812
Q13 Overall, I believe that chatting with Copilot is beneficial for my Chinese learning.	.759	.910
Q14 I believe that chatting with Copilot is beneficial for my Chinese learning.	.650	.925
Q15 I agree with the statement, "It is helpful for my Chinese learning to chat with Copilot."	.658	.801
Q16 Overall, I feel that I can enhance my Chinese learning through conversations with Copilot.	.606	.884
Q17 I intend to continue using Copilot to support my Chinese learning.	.650	.816

Table 2
Total variance explained.

Components	Extraction sums of squared loadings		
	Total	% of variance	Cumulative %
1	11.273	66.309	66.309
2	1.214	7.141	73.450

Table 3
Availability and effectiveness.

	Availability (PE)	Effectiveness (PU)
Mean scores	5.70	5.69
Standard deviation	1.15	1.17

educators in facilitating one-on-one real-time interaction practices online demonstrates discernible levels of effectiveness and accessibility within the context of SLA. Note that the average scores for both availability and efficacy approach the (6) Agree category, indicative of a favorable perception among participants. Nonetheless, these results also point towards potential areas for improvement in the LLM-based chatbot to optimize its efficacy within the field of SLA. It is imperative to underscore that the LLM-based chatbot employed in this study was not explicitly tailored for SLA objectives, suggesting avenues for further refinement and customization to better align with the specific requirements of language learning contexts.

5. Conclusions

In this paper, we proposed a study aimed at evaluating the accessibility and effectiveness of an LLM-based chatbot within the context of SLA to support real-time interaction practices

within classrooms, targeting students engaged in the acquisition of Chinese as a second or foreign language. We introduced an innovative study on SLA that leverages sound sensors and transducers. Effective speaking and listening interactions are essential in SLA, and LLMs can facilitate these interactions directly with students. The research delineates a structured application scenario involving real-time interaction practices facilitated by Copilot. The findings of this study indicate that the LLM-based chatbot demonstrates a degree of availability and efficacy, thereby partially substituting educators in facilitating one-on-one and real-time interaction practices online within the SLA process.

Moreover, the findings underscored the pressing need for improvements in the design and functionality of the LLM-based chatbot, ensuring alignment with the specific objectives and requirements of SLA. These insights provide valuable contributions to ongoing discussions surrounding the incorporation of technological advancements, exemplified by Copilot, as adjunctive aids in the domain of language education. This study is particularly pertinent within the context of SLA, where innovative approaches are continuously sought to optimize learning outcomes and facilitate effective language acquisition.

Within the scope of this study, the utilization of the LLM-based chatbot is restricted to supporting educators in delivering enhanced real-time interaction opportunities to learners. Looking ahead, our research endeavors will focus on a comprehensive analysis aimed at identifying the multifaceted factors that influence both the availability and effectiveness of the chatbot. This future direction highlights our commitment to advancing technological solutions in language education, focusing on optimizing interaction experiences and enhancing learning outcomes for learners engaged in SLA processes.

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