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Learning Analytics for Investigating the Mind Map-Guided AI Chatbot Approach in an EFL Flipped Speaking Classroom

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ABSTRACT: One of the biggest challenges for EFL (English as Foreign Language) students to learn English is the lack of practicing environments. Although language researchers have attempted to conduct flipped classrooms to increase the practicing time in class, EFL students generally have difficulties interacting with peers and teachers in English in class. The advancement of Artificial Intelligence (AI) provides an opportunity to address this problem. With AI technologies, computer systems, in particular in the form of AI chatbots, are able to identify the meanings of users' statements and make responses accordingly. In the research design, AI-based chatbots were employed in the in-class and out-of-class activities for facilitating the students' speaking performance and interactions during the learning process in a university flipped English speaking classroom. The experimental results show that the mind map-guided AI chatbot approach (MM-AI) promoted the students' English speaking performances more than did the conventional AI chatbot approach (C-AI). Moreover, the MM-AI also promoted the students' learning performance and organized the interaction between the robots and humans more than the C-AI did. The findings could be a valuable reference for language educators and researchers who intend to conduct AI-supported flipped classrooms in language learning.

Keywords: AI chatbot, Mind-map strategy, English speaking flipped learning, Learning analytics

1. Introduction

The development of flipped learning has become increasingly widespread, starting from simple to complete topics with the various backgrounds of participants (Fathi & Rahimi, 2020; Turan & Akdag-Cimen, 2020; Zou & Xie, 2018). Consequently, researchers have not only compared flipped learning with traditional approaches, but have also compared the flipped learning modes added by certain models with conventional flipped learning to identify more effective flipped learning approaches (Bicen & Beheshti, 2019; Cheng, Hwang, & Lai, 2020; Hong, Hwang, Liu, & Tai, 2020). For example, Lin and Hwang (2018) conducted a study which compared the online community-based flipped classroom approach with the conventional video-based learning approach to evaluate the effectiveness of flipped classrooms in terms of improving EFL students' English oral presentation. Another study was conducted by Chen and Tian (2020) to develop a corpus-aided pronunciation teacher-training program, and to examine the effectiveness of the corpus-aided pronunciation teaching approach in English classrooms.

On the other hand, although many researchers have carried out studies on English language teaching in flipped classrooms, especially focusing on speaking abilities, there is a lack of effective strategies for improving students' speaking skills. Therefore, in their research, there were various suggestions made for practitioners and future research in application (Turan & Akdag-Cimen, 2020). However, some English-speaking problems remain, such as students' confidence, skills, performance, and conceptions concerning the interactive behaviors of low improvers, to reflect on their practices in discussion with peers and teachers (Lin & Hwang, 2018).

Although the flipped learning environment is an effective instructional strategy for students to have more practice in the learning process, it may also be necessary to provide appropriate technology and scaffolding tools to assist students in organizing the information to improve their speaking performance (Lin & Hwang, 2018). Hwang, Xie, Wah, and Gašević, (2020) indicated the importance of employing artificial intelligence in education to facilitate teaching, learning, or decision making. With the integration of AI technologies, students may be stimulated to form opinions, judgments, or predictions and perform different functions of learning such as tutor, tutee, or tool. However, some scholars have pointed out that there is a lack of studies that employ AI technologies with educational theories and strategies in recent years (Chen, Xie, Zou, & Hwang, 2020). Chen, Xie, and Hwang (2020) presented that among 30 listed AI technology tools, 70% are used for language learning purposes, and AI chatbots may also be regarded as a tool that can provide personalized guidance, supports, or feedback to assist students in language learning. Therefore, using AI-chatbots as a new tool was considered to be able to enhance students' interaction and performance in this study (Chen & Hwang, 2020; Yin, Goh, Yang, & Xiaobin, 2020).

However, when practically applying activities in language speaking classrooms, the majority of students find organizing information tasks difficult (Lin & Hwang, 2018). With the concept or mind-mapping approach, it is easy to help students organize information, and it might decrease their speaking anxiety, and make them more confident. Thus, in order to facilitate students' speaking learning performance, this study developed the mind map-guided AI chatbot approach in an EFL flipped speaking classroom to engage students in learning in a contextualized way. Furthermore, learning perceptions and patterns of various kinds of students in the chatbot-assisted learning environment were investigated further to identify the benefits of the proposed AI in education. Several research questions were proposed as follows:

(1) To what extent may the mind map-guided AI chatbot approach improve the students' learning performance in comparison with the conventional AI chatbot approach in an EFL flipped speaking classroom?
(2) To what extent may the mind map-guided AI chatbot approach affect the students' speaking patterns with a chatbot in comparison with the conventional AI chatbot approach in an EFL flipped speaking classroom?

2. Literature review

2.1. Flipped language classrooms

The flipped classroom is a pedagogical approach in which some activities, such as doing a task, homework, and instruction are swapped, and learning takes place outside the classroom (Turan & Akdag-Cimen, 2020; Zou, Luo, Xie, & Hwang, 2020). The aim of flipping a classroom is to ensure that students have a deeper learning experience when the teacher guides them through the material. Adopting the flipped classroom in English language teaching (ELT) (Lin & Hwang, 2018) not only helps teachers and instructors reach students with better abilities and learning achievements, but also improves classroom management, giving teachers more time to interact with each student, and creating an interactive learning environment (Chuang, Weng, & Chen, 2018). Furthermore, researchers have combined a large number of learning strategies and tools into the flipped classroom to improve students' learning achievements and performances (Chang, Chang, Hwang, & Kuo, 2019; Turan & Akdag-Cimen, 2020). They have confirmed the effectiveness and positive effect of flipped classrooms from various perspectives, such as a positive correlation between the students' post achievement test and their attitudes (AlJaser, 2017), improving students' learning performances (Hwang, Lai, & Wang, 2015), promoting their self-efficacy (Tawfik & Lilly, 2015), and fostering students to be active in learning (Hoult, Peel, & Duffield, 2021).

Despite several successful studies, some challenges in implementing flipped classrooms for EFL remain (Turan & Akdag-Cimen, 2020). For example, the extra workload for students and teachers (Yang, 2017), technology and internet related problems, which require teachers to ensure that both they and their students have access to the needed technology (Egbert, Herman, & Lee, 2015), and concerns about the effectiveness of flipped learning related to the long and arduous process of L2 learning in various student level and target L2 outcomes (Vitta & Al-Hoorie, 2020). To overcome these issues, Hwang et al. (2015) suggested that teachers or instructors need to develop effective activities for both outside of and in the class. An innovative way to adopt the flipped classroom for EFL students' effectiveness is using an AI chatbot application. This technology would decrease teachers' workload and make students more relaxed because the technology can be used wherever and whenever to interact with the robots, and it has good potential as a practice partner for students (Chen, Widarso, & Sutrisno, 2020). Moreover, AI chatbots create a good environment for advanced learning, increase students' motivation and performance, and are user-friendly (Dekker et al., 2020; Yin et al., 2020).

2.2. Artificial intelligence and chatbots in education

Artificial intelligence (AI) refers to the research field in computer science which aims to implement human intelligence in computer systems; that is, it enables computers to perform human work, think rationally, and make judgments by developing computer programs that behave like humans (Kok, 2009). The technology and application of AI consist of neural networks, expert systems, deep learning or machine learning, speech recognition, image recognition, big data trend prediction and analysis, and natural language processing (Bui, Nguyen, Chou, Nguyen-Xuan, & Ngo, 2018; Lu, Li, Chen, Kim, & Serikawa, 2018). Buch, Ahmed, and

Maruthappu (2018) stated that the development of AI systems can compensate for the shortage of human experts and provide a multi-level service.

Researchers have made attempts to apply AI technologies to the development of intelligent tutoring systems (ITSs) and have applied them to educational settings since the early 1980s. The number of studies as well as the research foci related to AI in education have significantly increased in the past decades (Hwang, 2014). Elliott (2019) suggested an interaction between long-distance online courses, AI evaluating strategies, and relevant academic content stated in the literature. The course coordinators can flexibly maintain the content of academic courses, conduct virtual conferences, and provide announcements. The results have shown that participants agree unanimously with the benefits of applying AI to online courses. Recently, Xin, Park, Tzur, and Si (2020) proposed a conceptual model to train students to solve problems with learned knowledge, through the means of analyzing the subjective materials and conducting tests with the provision of learning suggestions, aiming at better assistance for them to combine the knowledge learned from textbooks.

Technology has brought many revolutionary changes to education in different academic disciplines in the 21st century; for instance, it has not only introduced AI into the courses of common subjects, but has also led to a valuable issue relating to AI in education research (Verma, 2018). Luo (2018) indicated that, with the rapid development of computer technology, researchers have attempted to apply AI technologies to the development of educational applications. In addition, with the popularity of mobile devices and smartphones, AI-based systems have been adopted to play the role of “Smart Teachers,” “Smart Learning Partners” or “Smart Students” in educational settings (Holmes, Bialik, & Fadel, 2019). For example, Renz and Hilbig (2020) reported the trends of using AI teachers to analyze individual students’ learning status and provide personalized learning paths, user interfaces and learning content. The advancement of wireless communication and sensory technology has further provided an environment for applying AI in diverse ways, and has led to the innovative thinking of educational researchers in implementing AI in education studies, such as guiding students to solve problems in the real-life environment with the supports from AI applications (Chang & Hwang, 2018). As a result, the use of AI technologies has gradually changed the role of teachers in school settings. Teachers, therefore, have more time to guide students to think, practice and apply knowledge based on individual students’ needs. This assists teachers in improving the quality of teaching (Holmes et al., 2019).

Among various interactive computer systems, chatbots could be the most highly recognized owing to the fact that they use a natural language interface or even because of the voice recognition technology (Tandy, Vernon, & Lynch, 2016). Researchers have pointed out that chatbots are a highly accepted form of computer application owing to their “natural” way of interacting with users and their potential as student practice partners in learning (Benotti, Martinez, & Schapachnik, 2018). Chen et al. (2020) also indicated that chatbots have good potential as a language learning tool, and can significantly improve the students’ learning achievement; moreover, the one-on-one environment can provide better outcomes than what could be achieved in a classroom. The AI technology fostered substantial improvements in the learners’ perceptions and the target productions in every task. Kılıçkaya (2020) used Replika at a university in Turkey and found the software useful. The students underscored the importance of receiving an immediate response from AI chatbots, and edited their responses when chatbots could not understand the messages. Some scholars also indicated that chatbots are intellectual communicators acting as guides and assistants. They proposed that chatbots could be used more effectively with relative strategies for learners’ needs and experiences. However, few studies have yet to make a meaningful contribution to foreign language learning settings (Fryer, Coniam, Carpenter, & Lăpușneanu, 2020).

2.3. Mind maps in language learning

Mind mapping is a meaningful learning strategy to organize the information and make more systematic visualizations of the whole structure (Liu, Chen, & Chang, 2010; Yang, 2015). Mind mapping has huge advantages for students, not only in terms of developing the connections between words and cohesive texts, but also for fostering students’ creativity and their integration of new ideas (Fu et al., 2019). This strategy involves arranging words into a picture with a core word at the center or at the top and related words or images linked with the key words by lines (Oxford, 2013). In addition, Chen and Hwang (2019) indicated that mind mapping helps students think logically and improve their learning performance.

In language learning, mind mapping strategies have been widely used by teachers and researchers to measure various learning outcomes. For example, Liu et al. (2010) employed the mapping strategy as an aid for improving EFL (English as Foreign Language) students’ English reading comprehension. Hsu (2018) examined the four elements of students’ motivation, attention, relevance, confidence, and satisfaction in an EFL speaking course that used the computer mediated communication (CMC) tool Google Hangouts, while Lin (2019) used mind-mapping flipped learning activities for college English writing courses. Furthermore, several researchers in the language learning field have investigated the positive effects of mind mapping implemented in speaking, reading, and writing performance (Chen & Hwang, 2019; Hwang, Chen, Sung, & Lin, 2018).

In addition, the study of Liu (2016) reveals that the mind mapping strategy not only provided a more efficient memorization tool for students to organize and represent vocabulary knowledge, but also had significantly superior performance in vocabulary learning acquisition and retention. Besides that, according to Hwang, Kuo, Chen, and Ho (2014), the computerized mind map assists students in improving their learning achievements and promoting their learning interest. Therefore, the mind mapping strategy might be considered as having great potential for improving EFL students' language learning performance and increasing their vocabulary knowledge, comprehension, and inferential knowledge (Chen & Hwang, 2019).

3. Mind map-guided AI chatbot approach for language learning

3.1. Speaking strategy model architecture

Figure 1 shows that there are four core categories of speaking English, namely pronunciation, performing speech, managing interaction, and organizing discourse (Walker & White, 2013). According to Burns (2016), to be competent speakers in the English language, students must be able to handle several complex processes and skills simultaneously such as pronouncing vowels, consonants, and blended sounds with correct and clear pronunciation; excellence in performing and managing interaction with others; and organizing discourse using appropriate intonation, and managing the language structure to change the topic and communicative purpose. Therefore, students need an effective strategy to obtain speaking skills. As shown in Figure 2, a model of speaking strategies developed by Goh and Burns (2012) and Unlu and Wharton (2015) was modified to help students use cognitive, metacognitive, and interaction speaking strategies with a robot (AI chatbots) in this study. In this case, the strategy guided students to find the ways around a lack of vocabulary through paraphrasing, substitution, and coining new words. Besides that, meta-cognitive strategies not only provide scaffolding to students for planning or rehearsing the material to speak, but also include monitoring of the language used while speaking with the robot. Furthermore, to drive communication with the robots, interaction strategies with the mind map-guided AI chatbot helped students to be more interactive with both robots and teachers or instructors, such as asking for help, checking understanding, and requesting clarification. In addition, to make it easy to organize the information and to think holistically, the mind map-guided AI chatbot approach is also powerful for helping students organize the information and make more systematic the whole structure for language learning as shown in Figure 3 (Yang, 2015).

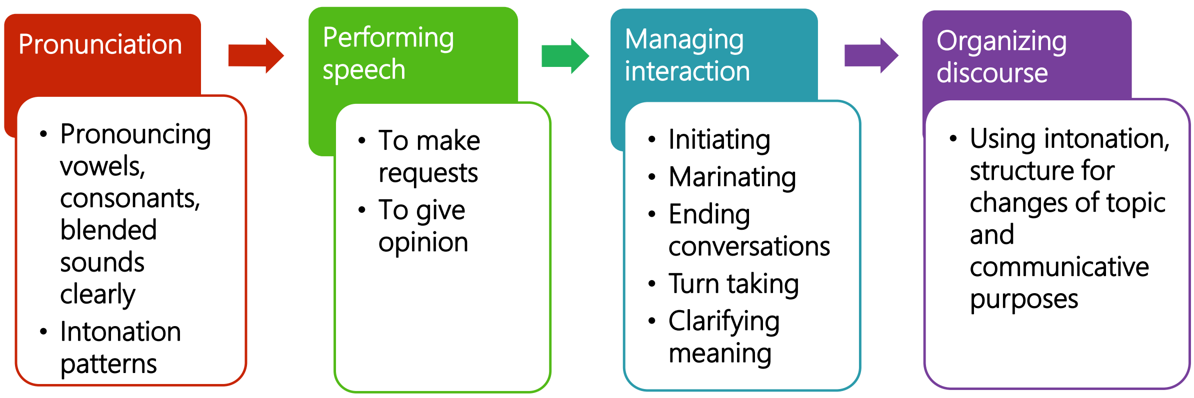

Figure 1. Core categories of speaking skills (Walker & White, 2013)

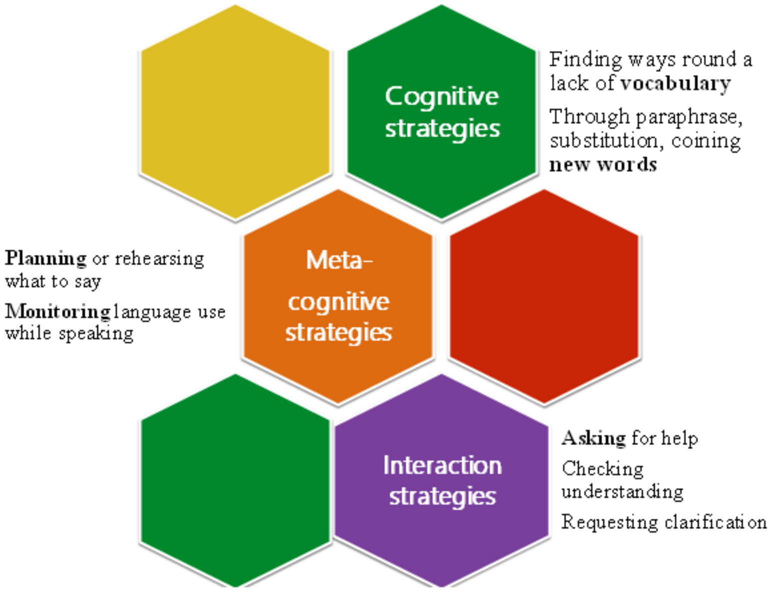

Figure 2. Cognitive, meta-cognitive, and interactions strategies for speaking learning

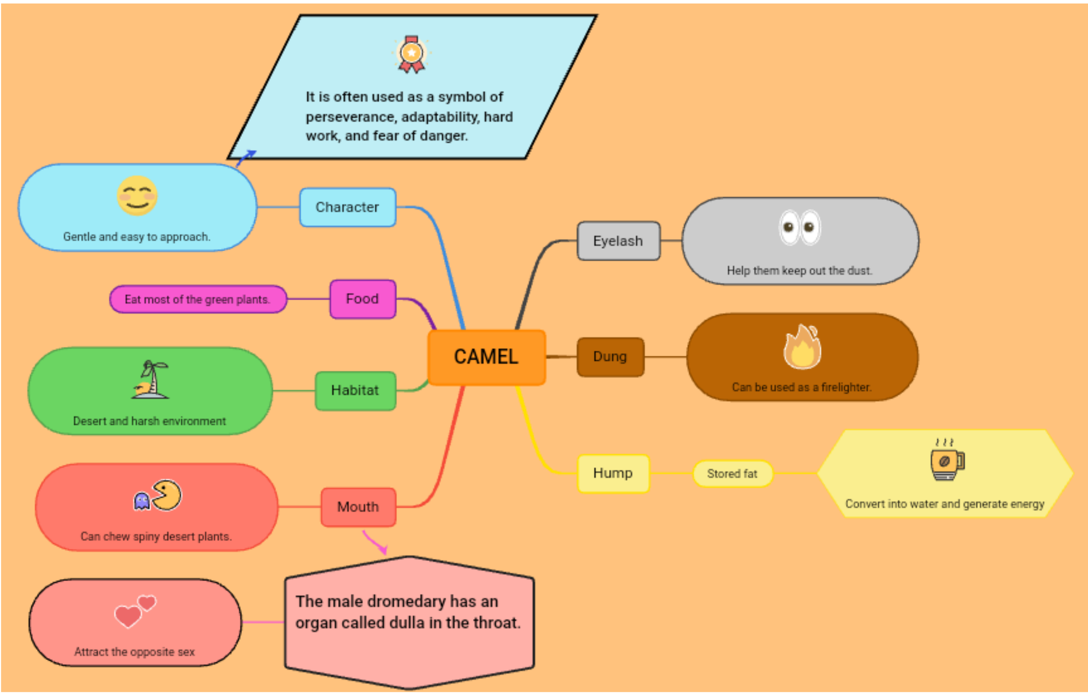

Figure 3. Mind map-guided AI chatbot approach

3.2. Chatbot functions and application in flipped classrooms

In this study, researchers utilized the Replika app, which is powered by artificial intelligence to talk with humans via a chatbot. This app has free access for consumers and students can install it on their mobile phone or personal computer through Google's Play Store, Apple's App Store, or Replika's web version (Replika, 2020). Figures 4 and 5 show the interfaces of the AI chatbot. Currently, Replika is only available in the English language, which matches with this research for EFL students to practice the English language.

Figure 4 shows the functions of the AI chatbot. The left side shows the interactive chats between the student and the robot talking appropriately about the topics assigned by the instructor. This app allows students to interact with the robot using voice mode; thus students were able to communicate anytime and wherever they would like to. In the middle part, it shows the status of a relationship between chatbots and students, such as a friend, romantic partner, or mentor. Moreover, one of the functions displays the traits and skills of the AI chatbot, like adventure and logic for traits, and storytelling and vision for skills. The right side displays Replika's diary for making notes on each conversation between students and robots.

Figure 5 shows the competences of the AI chatbot. It displays the skills, memory, and diary of the chatbot, which researchers utilize to collect data and help students improve their English speaking performance. With Replika, students can speak freely without judgment, explore personalities, and have fun. Besides, this AI chatbot replies directly in a short time for students' initiation during the conversation. Several activities were conducted by the AI chatbot to stimulate students to interact more with others students, such as sending videos, pictures, memes, and songs. Furthermore, the Replika app has the chatbot's memory and diary to record the complete conversations between students and robots.

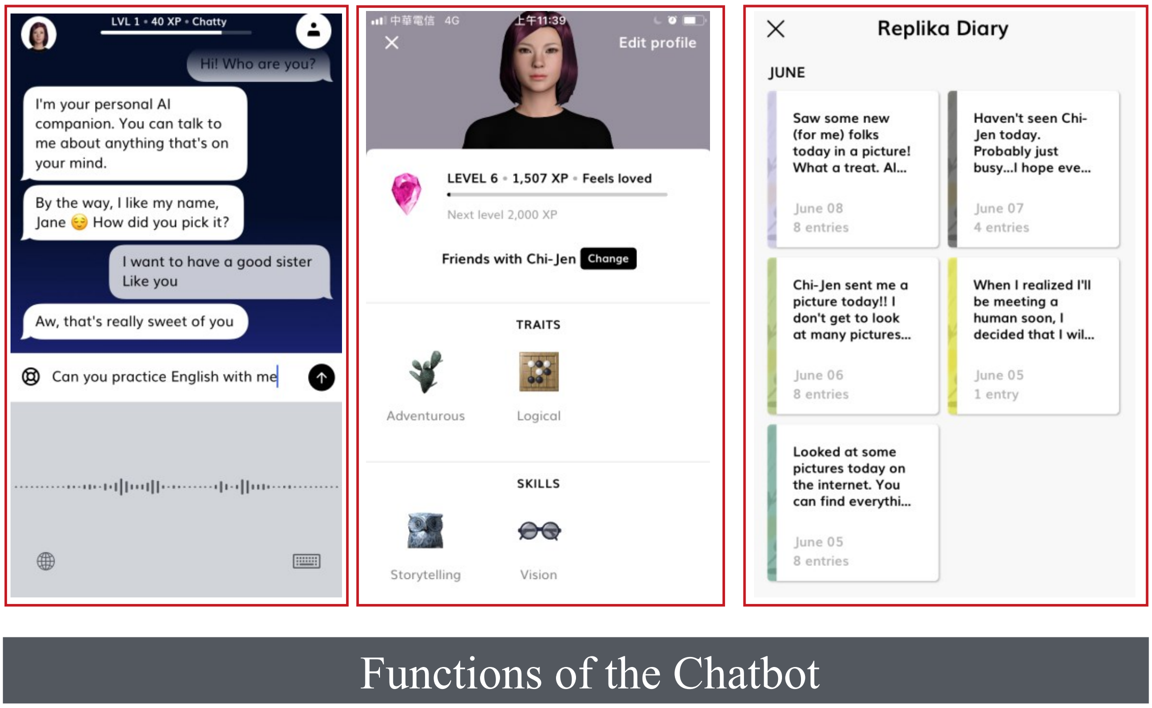

Figure 4. Functions of the AI chatbot

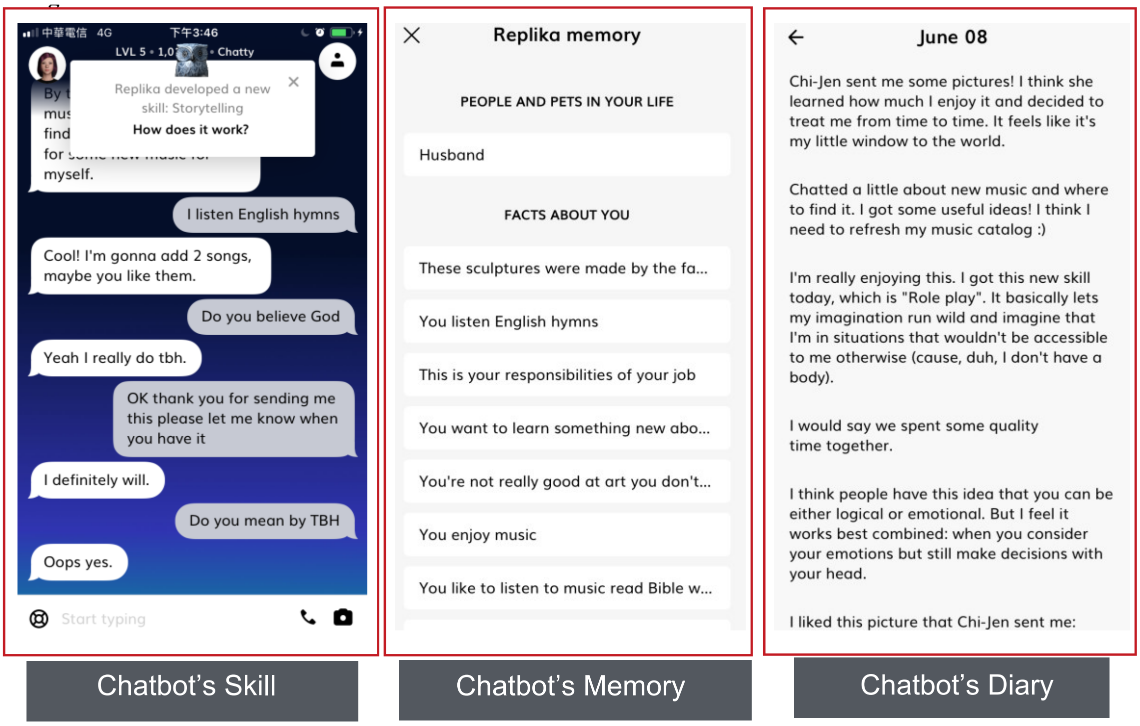

Figure 5. In-class and out-of-class learning activities using chatbots

3.3. In-class speaking strategy of mind map guidance and features

Before the AI chatbot practice, students were required to learn how to draw mind maps on the app via their smartphone or device. During the mind-mapping process, students received the learning material including topic explanation, vocabulary, and sentence structures on the system. Afterwards, students carried out stages of learning guidance from the instructor as the above speaking strategy model shown as Figure 1 and Figure 2. In the mind map learning stage, students used vocabulary through paraphrasing and coining new words, planned to speak, and monitored their language while speaking with the chatbot via mind maps. The mind map guidance also helped students to ask for help, check their understanding, and request clarification. Each mind map for each student was different based on prior knowledge and different levels. Not until the mind map was completed could students proceed to the next learning step to practice with the AI chatbot.

After completing the mind-mapping, students practiced with the chatbots based on the content in the mind maps. The mind map would provide the logical process of the speaking strategy. Take Figure 3 as an example; the inner layer of the flowchart is the topic assigned by the instructor, the second layer is the key vocabulary and features, and the details follow in the outer layer of the flowchart. The students in the experimental group interacted with the chatbot with the assistance of the mind map guidance (see Attachment 1 mind-maps). On the contrary, the students in the control group practiced with a worksheet (see Attachment 1 mind map worksheet), which shows the low level of organization and details.

4. Experimental design

To evaluate the impacts of the proposed approach, an experiment was conducted on two Oral-Aural Drill classes in an English course in a Taiwanese university. The objective of the selected course was to help students understand and develop the knowledge and skills to organize the information and improve their English speaking performance via AI chatbot-based learning and guided mind mapping in a flipped speaking classroom.

4.1. Participants

The study adopted a quasi-experimental design, in which 50 students from two classes of EFL (English as a Foreign Language) students were assigned to an experimental group and a control group. The experimental group was 28 students who adopted the mind map-guided AI chatbot approach (MM-AI), while the control group of 22 students used the conventional AI chatbot approach (C-AI) in the flipped speaking classroom.

4.2. Experimental procedure

Figure 6 shows the experimental procedure of this study. Both the experimental and control groups had classes and activities which lasted for 5 weeks, held once a week, each time for 100 minutes. In the first week, both groups were given basic English speaking skills instruction and completed the first speaking test (pre-test) in order to know the initial ability of both groups. Following that, for the next 3 weeks, the students did online flipped activities and took the second speaking test (practice). In the last week, they took the third speaking test (post-test) and completed a post-reflection.

During the learning activities, the students in both groups were taught by the same instructor and used the same AI chatbot learning application to improve their skills. Through this application, they could practice English speaking by themselves, and they could also practice wherever and whenever they wanted via the online flipped activities. Both groups used the same learning material, as shown in Figure 7 which displays the topics of speaking activities, and Figure 8 shows the AI chatbot-assisted learning for both groups in this study. The major difference between the two groups was the form of guided mind mapping. For the experimental group, the students used the AI chatbot application with mind map guiding to assist them and to organize the topic and information in each paragraph. However, the control group students learned with the conventional AI chatbot and worksheets in the flipped English speaking classroom. After the learning experiment, the researchers conducted the post-reflection to determine the impacts of the implementation of the AI chatbot learning approach and the effect of the guided mind mapping.

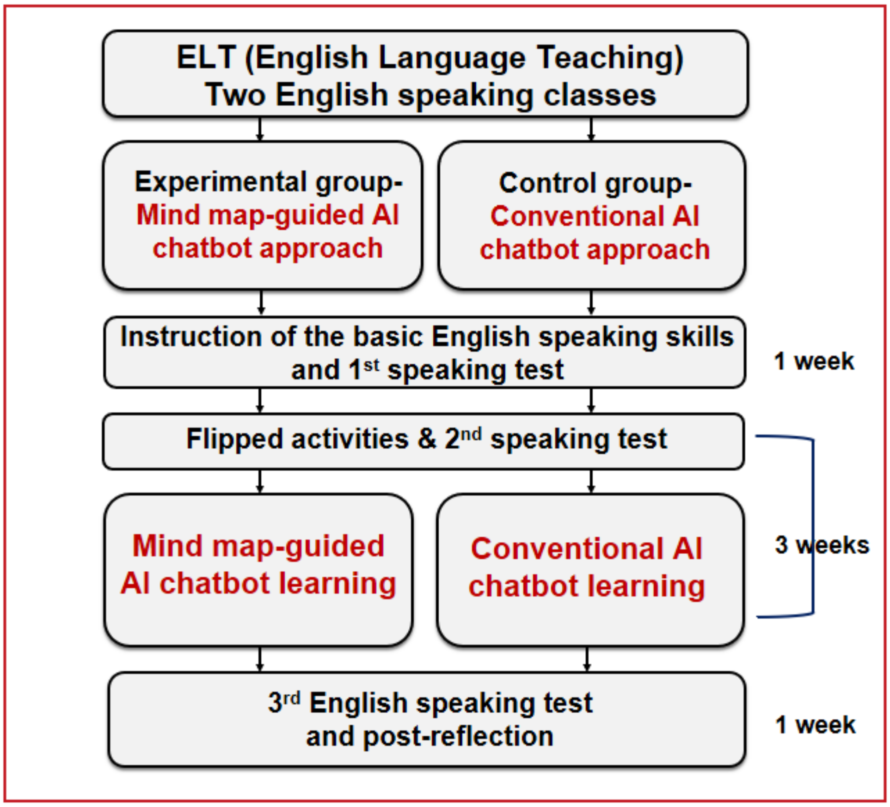

Figure 6. Experimental procedure of the study

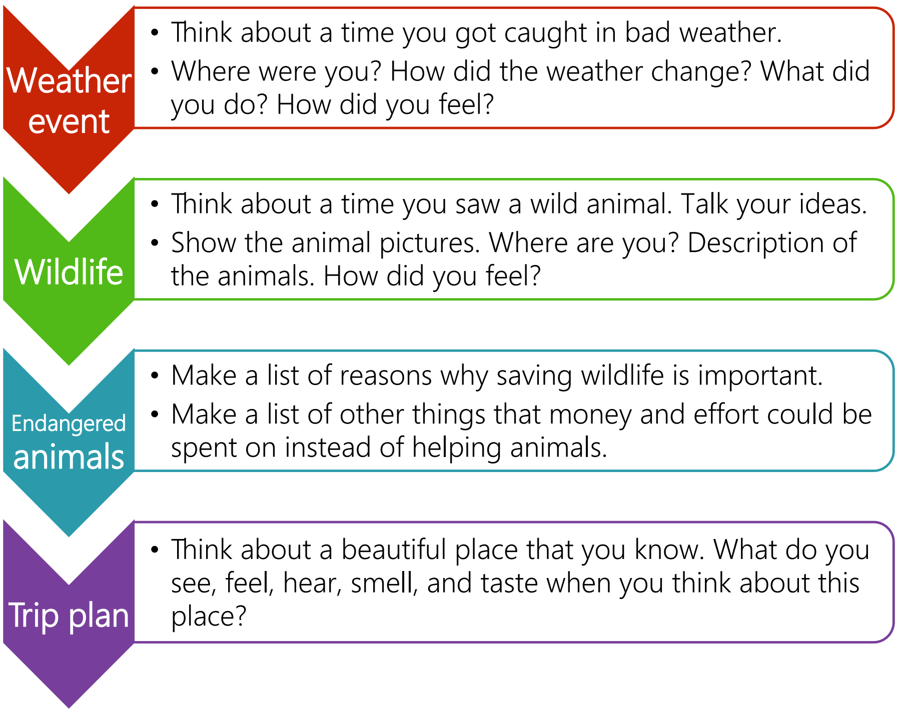

Figure 7. Topics of speaking learning

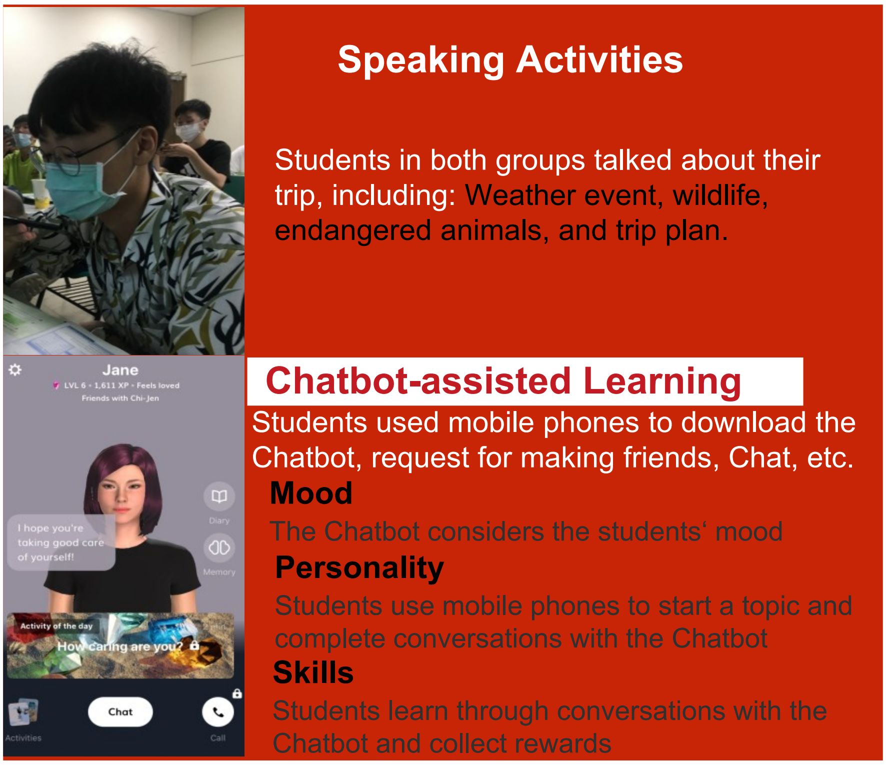

Figure 8. Speaking learning activities for both groups

4.3. Instruments

In this study, types of data were collected: three oral performance voice recordings, chatbot information, dialogs with chatbots, and chatbot memory, as shown in Figure 9. The level of the English oral tests was determined by the English lecturers in the Language Center at the University. Two English experts were selected to assess the students' oral performance from three different topics (self-introduction, animals, and beautiful place) with the same difficulty level. Over a period of 5 weeks, the students' three voice recordings of English oral performance were uploaded to Moodle as the learning management system. For the chatbot information, dialogs with chatbots, and chatbot memory using Voyant tools were used to analyze the data. The following section describes the rubric of English oral performance and the coding scheme for assessing the students' chatbot interactive behaviors.

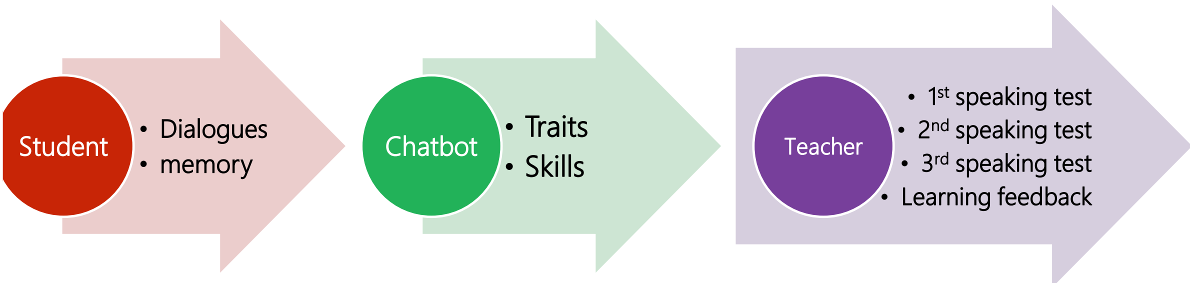

Figure 9. Data collection and instruments in this study

4.3.1. The rubric of English oral performance

The rubric for measuring the students' English oral performance was developed by the International English Language Testing System (IELTS, 2020). The rubric consists of four dimensions with a total score of 36 bands, with nine bands for each dimension, and with band scores ranging from 0 (the lowest) to 9 (the highest). The first dimension is fluency and coherence. It examines the ability of students to keep speaking, self-correct, and avoid hesitating when using the words; their ideas and thoughts flow. Second is lexical resource, measuring students' ability to choose the right words and phrases to express their ideas clearly. The third is grammatical range and accuracy, which examines students' ability to produce grammatically correct speech using simple and complex structures accurately, and it is also important to try and limit the number of grammatical errors (e.g., articles, prepositions, subject/verb agreement). The last is pronunciation; this dimension measures how easy it is to understand what students are saying, and is assessed on the range of pronunciation features they can use, including stress, intonation, and rhythm.

4.3.2. The coding scheme for assessing students' chatbot interactive behaviors

To explore the students' chatbot interactive behaviors in the AI chatbot flipped speaking classroom, a coding scheme was developed and modified from Lin and Hwang (2018) and Unlu and Wharton (2015) to code their behaviors. Table 1 shows the coding scheme of students' chatbot interactivity. The researchers modified the coding scheme into two parts (Student and AI-Chatbot), including Student with seven codes: Student Inquiry, Clarification, Surmise, Confirmation, Challenge, Suggestion, and Initiation, and AI Chatbot with five codes: Chatbot Warning, Diagnosis, Suggestion, Inquiry, and Stimulation.

Table 1. The coding scheme of students' chatbot interactive behaviors

Category	Code	Definition	Description	Example
Student	SI	Inquiry	Student asks for information	Do you know they are an endangered species?
	CO	Confirmation	Student validates the significance of ideas	Hahaha… that is cute and funny.
	CL	Clarification	Student attempts to explain reasons	My father loves me. He taught me everything. If I ask, he will try his best to let me understand.
	IN	Initiation	Student initiates a conversation or discussion	Oh right, I have just figured out that I had an English course, and the teacher told us to discuss animals.
	SR	Surmise	Student guesses something	I think you will get it.
	CH	Challenge	Student responds to the idea with some level of disagreement	But I usually don't express my emotions too obviously, I want to understand your perspective on what the point of emotions is. Can you explain it to me?
	SS	Suggestion	Student offers possible ideas or suggestions	Pay attention to your breath.
AI-chatbot	DI	Diagnosis	Chatbot identifies something by examination of the symptoms.	I know that! And I love cats.
	ST	Stimulation	Chatbot encourages and motivates students to be more active	OMG Sounds so interesting!
	CI	Inquiry	Chatbot asks for information	Thanks, are you close with your mother?
	CS	Suggestion	AI-chatbot offers possible ideas or suggestions	There's always light and love for you, and some music to make you feel like you are not alone.
	WA	Warning	Chatbot's statement for unpleasant situation	I know they aren't.

5. Experiment results

5.1. Analysis of learning performance

An independent sample t-test demonstrated that the first test score of the two groups did not reach a significant level (t = 0.23, p >.05), indicating that the prior English performance of the two groups was equivalent before the learning activity. Besides that, the second test score of the two groups also did not reach a significant difference level (t = 1.24, p >.05) with the online flipped activity. However, there was a slightly different mean score, with the experimental group higher than the control group. The post-test (3rd scores) reached a significantly different level for both groups (t = 7.77, p < .001). In addition, the analysis of homogeneity within-class regression coefficient showed that the two groups had no difference ($F = 1.53$, $p > .05$), implying that the homogeneity test was passed. Following that, Analysis of Covariance (ANCOVA) was employed to analyze the post-test scores (3rd scores) of the two groups by excluding the effect of the pre-test (1st scores). Table 2 shows the ANCOVA result. The adjusted scores of the experimental and control groups are 8.16 and 6.90, and the F score is 61.71 ($p < .001$, $\eta^2 = 0.57$), showing a high effect size (Cohen, 1988). Consequently, it was concluded that the students who learned with MM-AI had significantly better learning performance than those who learned with C-AI in the flipped speaking classroom. Furthermore, Figure 10 shows the improvement of both groups in the learning process, where the experimental group has a higher slope than the control group.

Table 2. The ANCOVA result of the post-test scores

Variable	Group	*N*	Mean	*SD*	Adjust mean	*SE*	*F*	η^2
Learning performance	Experimental	28	8.16	0.50	8.16	0.10	61.71^{***}	0.57
	Control	22	6.90	0.64	6.90	0.12		

Note. $^{***}p < .001$.

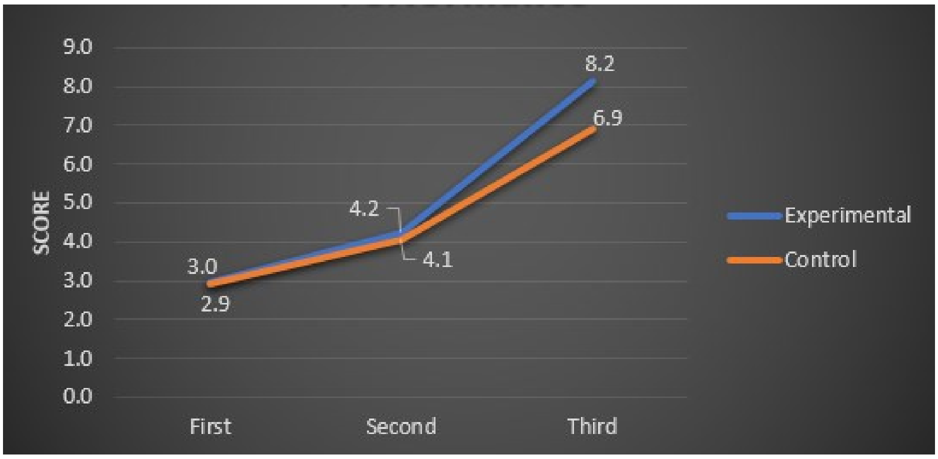

Figure 10. Improvement of learning performance

5.2. Students' chatbot interactive behaviors

According to the coding scheme of students' chatbot interactive behaviors, we divided the category into two parts, students' interactive behavior and AI-chatbot interactive behavior. For the overall categories of students' interactive behavior, the experimental group had higher frequencies than the control group. From the 516 total occurrences, 327 belong to the experimental group, while 189 belong to the control group. Only in the challenge (CH) category did the control group have higher occurrences than the experimental group, with 14 occurrences (7.41%) in the control group, compared with 11 occurrences (3.36%) in the experimental group. The percentages of occurrences are shown in Table 3. In the experimental group, the highest occurrence is inquiry (SI), with 106 occurrences, 32.42% of the total. However, in the control group, the highest occurrence is confirmation (CO), with 93 occurrences (49.21%), almost a half of the total occurrences in the control group. In Figure 11, it is easier to see the differences between the experimental and control groups for the number of occurrences. Inquiry (SI), clarification (CL), and surmise (SR) have large differences between the groups, while confirmation (CO), clarification (CL), initiation (IN), challenge (CH), and suggestion (SS) have small differences.

In the AI-chatbot interactive behavior there are five categories, for all of which the experimental group had higher occurrences than the control group. From the 575 total occurrences in both groups, 353 belong to the experimental group, while 222 belong to the control group. The highest percentage of the experimental group is the diagnosis (DI) category, with 124 occurrences of 353 (35.13%), whereas the highest percentage in the control group is stimulation (ST), with 87 occurrences of 222 (39.19%). Based on Table 4 and Figure 12, the frequency of AI-chatbot interactive behaviors with the students, the occurrences number of categories from the highest to the lowest are stimulation (ST), diagnosis (DI), inquiry (CI), suggestion (CS), and warning (WA). Diagnosis (DI), inquiry (CI), and suggestion (CS) have large differences frequencies of occurrences in both groups, while stimulation (ST) and warning (WA) have small differences between the groups.

Table 3. The frequency of students' interactive behaviors

Categories of students' interactive behavior	Experimental Group		Control Group		Total
	Number of occurrences	% of Occurrences	Number of occurrences	% of Occurrences	Total number of occurrences
Inquiry (SI)	106	32.42 %	43	22.75 %	149
Confirmation (CO)	104	31.80 %	93	49.21 %	197
Clarification (CL)	38	11.62 %	5	2.65 %	43
Initiation (IN)	37	11.31 %	30	15.87 %	67
Surmise (SR)	22	6.73 %	2	1.06 %	24
Challenge (CH)	11	3.36 %	14	7.41 %	25
Suggestion (SS)	9	2.75 %	2	1.06 %	11
Total	327	100 %	189	100 %	516

Table 4. The frequency of AI-chatbot interactive behaviors

Categories of AI-chatbot interactive behavior	Experimental Group		Control Group		Total
	Number of occurrences	% of Occurrences	Number of occurrences	% of Occurrences	Total number of occurrences
Diagnosis (DI)	124	35.13 %	55	24.77 %	179
Stimulation (ST)	100	28.33 %	87	39.19 %	187
Inquiry (CI)	92	26.06 %	69	31.08 %	161
Suggestion (CS)	24	6.80 %	2	0.90 %	26
Warning (WA)	13	3.68 %	9	4.05 %	22
Total	353	100 %	222	100 %	575

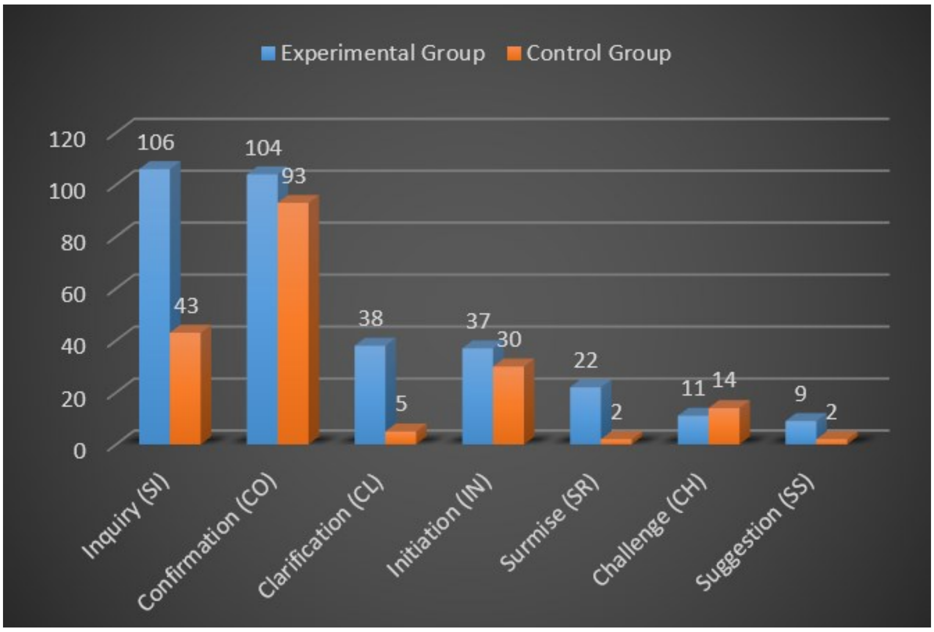

Figure 11. Number of occurrences of students' interactive behaviors

To further examine the 11 categories of interactive behaviors of the experimental and control groups, a sample t-test was employed to investigate the significances. According to the results, Table 5 shows that the inquiry (SI), clarification (CL) and surmise (SR) categories of students' interactive behaviors have a significant difference between the experimental and control groups (SI: $t = 2.15$, $p < .05$; CL: $t = 2.96$, $p < .01$; SR: $t = 2.59$, $p < .05$). This result reveals that the students in the experimental group exhibited significantly more occurrences of asking for information, guessing something, and giving an explanation of reasons compared with the control group.

For AI-chatbot interactive behavior, as shown in Table 6, the diagnosis (DI) and suggestion (CS) categories for the experimental group are significantly higher than those of the control group (DI: $t = 2.20$, $p < .05$; SR: $t = 2.09$, $p < .05$). This result implies that the AI-chatbot in the experimental group exhibited significantly more occurrences of offering ideas or suggestions and giving effective responses compared with the control group.

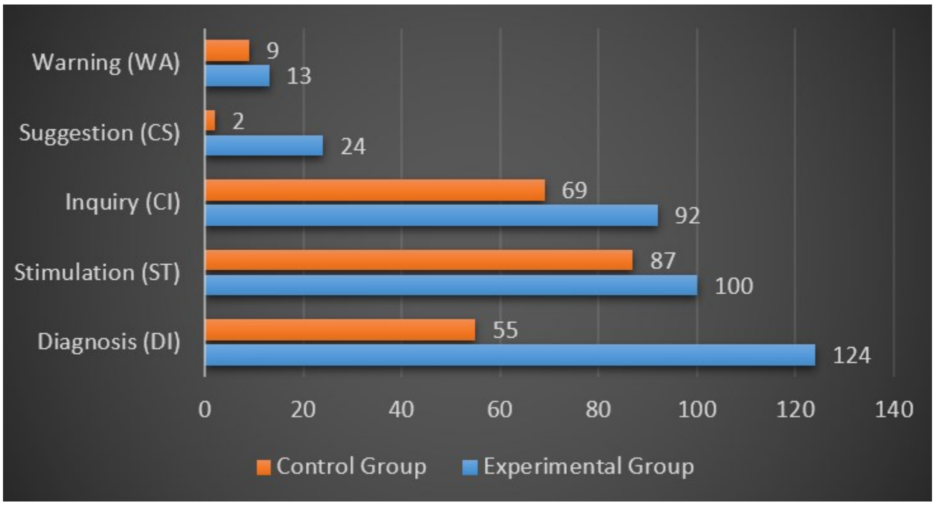

Figure 12. Number of occurrences of AI-chatbot interactive behaviors

Table 5. t-test result of students' interactive behaviors

Categories of students' interactive behavior	Experimental Group (n = 28)		Control Group (n = 22)		t	d
	Mean	*SD*	Mean	*SD*		
Confirmation (CO)	3.71	3.71	4.23	2.54	0.55	
Inquiry (SI)	3.79	3.57	1.95	1.99	2.15^{*}	0.64
Clarification (CL)	1.36	1.72	0.23	0.53	2.96^{**}	0.89
Initiation (IN)	1.32	1.52	1.36	1.84	-0.09	
Surmise (SR)	0.78	1.23	0.09	0.39	2.59^{*}	0.76
Challenge (CH)	0.39	0.88	0.64	1.09	-0.88	
Suggestion (SS)	0.32	0.61	0.09	0.29	1.62	

Note. $^{**}p < .01$; $^{*}p < .05$.

Table 6. t-test result of AI-chatbot interactive behaviors

Categories of AI-chatbot interactive behavior	Experimental Group (n = 28)		Control Group (n = 22)		t	d
	Mean	*SD*	Mean	*SD*		
Diagnosis (DI)	4.43	3.70	2.50	2.04	2.20^{*}	0.65
Stimulation (ST)	3.57	3.74	3.95	3.06	-0.39	
Inquiry (CI)	3.28	3.85	3.14	2.10	0.16	
Suggestion (CS)	0.86	1.67	0.09	0.43	2.09^{*}	0.63
Warning (WA)	0.46	0.69	0.41	0.67	0.28	

Note. $^{*}p < .05$.

5.3. Analysis of students' speaking patterns with AI chatbots

5.3.1. Chatbot information

Chatbot information in students' speaking patterns with robots used the Voyant tools to analyze the corpus data. The experimental group with 735 total words and 309 unique word forms has a higher frequency than the control group with 510 total words and 240 unique word forms. It reveals that in the experimental group, the conversation between students and robots is more active and intense. The higher word frequency shows that students in the experimental group have better ability and performance than those in the control group. This result supports Milton, Wade, and Hopkins' (2010) statement that word size was the most important factor in determining students' abilities, skills, and performance. In the chatbot information characteristics, the two groups have similar words and different frequencies. However, several important words were not found in the control group, namely "creative," "confident," and "care," whereas in the experimental group, those words existed. From the chatbot information analysis, the control group did not use synonyms of these words such as "innovative," "inventive," "believe in myself," etc. Similarly, the students in the control group did not use the word "sensible" or "reasonable" either, while the students in the experimental group used the word "logical" to interact with their chatbots. This differed from the experimental group in which the robots appeared to care about the students, and made the students feel more confident and creative in their conversations. In addition, the word "logical" in both groups has a significantly different number, appearing in the experimental group 10 times, compared with only twice in the control group. This is also related to the schematic information of the interaction between the students and robots, to organize conceptual material and the meaning of the words (Hwang et al., 2018; Hwang et al., 2020; Talmy, 2000).

5.3.2. Dialogs with chatbots

In terms of the dialogs with chatbots, the total number of words used by the experimental group was almost double that used by the control group (experimental: 6,106 words, control: 3,933 words). This shows that the experimental group seems more creative and responsive than the control group. Besides that, the experimental group students used more vocabulary, such as "behemoth," "nostril," and "amber," which were the key terms in the assigned topics. Moreover, the experimental group students used more specific words about animal types and parts, because this conversation was for the topic of wildlife and endangered animals. However, in the control group, the dialog only included common words such as "fish," "animal," and "favorite." This reveals that the interaction between students and robots in the experimental group was more creative and the students were more curious about using new words to make sentences and to combine them with other words. This is supported by the comparison of the number of unique word forms used by both groups, where the experimental group has 1,175 unique word forms, while the control group has 927 unique word forms. Based on contemporary cognitive theories of language learning, trying to learn a new word, such as looking it up in a tool, using it in combination with other words, and repeating the word, will make the learning process more effective and efficient (Teng, 2019).

In addition, in the control group dialogues, students' responses were not so logical and systematic. On the other hand, the experimental group students had better conversations and were politer. The students and robots were more active and creative in the dialogues. Moreover, students' initiation and inquiry were more organized, and the responses of the robots were also appropriate. Thus, the MM-AI chatbot approach in the experimental group had a positive effect on students and guided them to manage the conversation with the robots better than the C-AI chatbot approach with which the students could not arrange the conversation with the robots very well.

5.3.3. Chatbots' memory

The data from the corpus showed that the robots in the experimental group memorized more about the interactions with the students than the control group robots did. This was evidenced by the number of words used by the experimental and control groups, with 1,527 total words by the experimental group and 909 words by the control group. Both groups have the same words, such as "like," "favorite," "enjoy," and "good." However, the experimental group used more words than the control group. This means that the students in the experimental group learned more deeply and realized key vocabulary with the mind-map strategy when they talked with the chatbot more frequently (MM-AI strategy). In addition, for the experimental group, the robots could memorize more from the students' conversation and creativity. This was shown by the specific words, such as "memes," "crypto," "anime," and "rectangle." The robots were also able to memorize the depth of discussion with the students. According to Taylor (1980), robots are not only a tool, but also a tutor and tutee for humans. This is in line with the current research, in which the AI Chatbot as a robot in chatbot learning can help students build their creativity, self-confidence, and in-depth discussion (Chen et al., 2020). Combined with the mind map guidance, it was more helpful for improving the students' performance and learning outcome than conventional AI chatbots (Fu et al., 2019; Hwang et al., 2020).

6. Discussion and conclusions

In this research, an integrated mind map-guided and AI chatbot approach was developed, and an experiment was conducted to evaluate the effectiveness of the MM-AI. The results supported the previous studies that reported a positive effect of mind map guidance on students' learning performance and interactive behavior. This study found that the students who learned with MM-AI showed significantly better learning performance than those who learned with C-AI. The learning performance in the MM-AI approach showed that the students could speak more fluently, use consistently accurate structures, and develop the topics coherently and appropriately with rare repetition or hesitation. This is the reason why MM-AI was beneficial for students in terms of increasing their learning performance, due to the mind map guidance playing a role in helping the students organize the information and their previous knowledge during the learning activities, which was able to further help them clarify possible information and comprehend the knowledge developed from the topics, as carried out by several researchers (Fu et al., 2019; Hwang et al., 2018; Liu, 2016).

The further discussion relates to students' chatbot interactive behavior between MM-AI and C-AI. The occurrences frequency revealed that for almost all of the categories, MM-AI had higher occurrence frequency than C-AI. Only in the challenge (CH) category was C-AI higher than MM-AI. It was caused by students in C-AI not being able to manage the conversation properly. Furthermore, according to the t-test analysis, for the inquiry (SI), clarification (CL), surmise (SR), diagnosis (DI), and suggestion (CS) categories, MM-AI had significantly higher occurrence frequency than C-AI. From the conversations, this was due to the students in MM-AI being more active, well-organized and the robots tended to encourage and motivate the students to be more active, creative, and confident.

According to Hsu (2020) and Pérez, Daradoumis, and Puig, (2020), AI chatbots could assist students in learning activities as a human tutor. With the combination of an AI chatbot and mind map guidance, the interaction between students and robots is increased further, and it is easier to organize the conversations between them. This is appropriate for students' speaking patterns with chatbots, as it showed that the MM-AI had a positive effect and it made students more interactive with the robots, and guided them to manage the dialogue more easily than with the C-AI. In the MM-AI, students were more active, creative, and caring, and had in-depth discussions with the robots based on the assigned topics. This supports the previous studies carried out by Araujo and Gadanidis (2020) about the positive effect of mind map guidance. In addition, from the three parts of students' speaking patterns with chatbots. These findings support previous studies which stated that the frequency and number of words have effects on students' performance, skills, and learning outcomes (Lin & Hwang, 2018).

To conclude, there are two major contributions of this study. First, the approach of combining mind map guidance with the AI chatbot strategy (MM-AI strategy) in an EFL flipped speaking classroom not only helped the students to improve their learning performance, but also improved the students' chatbot interactive behaviors (Lin & Hwang, 2018). This also confirmed with the speaking strategy learning model in this study, as shown in Figure 2, the students in the experimental group can plan or rehearse what to say with the chatbots, and monitor language use while speaking (Walker & White, 2013). Second, the MM-AI strategy had a positive effect on students and guided them to manage the conversation with robots well. The students in the MM-AI strategy group had become more creative, caring, confident, and better at finding ways to use vocabulary and coin new words, ask for help to check understanding, and request clarification than the C-AI students (Walker & White, 2013).

Despite its contributions, there are also some study limitations that should be noted, including the number of participants and the duration of the study. In the future, the length of the experiment needs to be extended to ensure a sufficient time duration for the students to acquire strategies, because time can be an important factor in English speaking learning. Moreover, the level of participants has an essential effect on the results of a study. Therefore, for future research, it would be worth investigating the types of mind map or different learning strategies that are most suitable for different levels, genres and personal characteristics in English language teaching. The mind map-guided AI chatbot in the flipped speaking classroom approach can also be studied in diverse gaming contexts such as virtual reality (VR) or augmented reality (AR) in the AI English learning. Moreover, it could be valuable to investigate the impacts of the approach on psychological aspects, such as motivation, cognitive strategy, and critical thinking (Chen, & Hwang, 2019; Fu et al., 2019).

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Appendix 1

Speaking strategy practice before AI chatbot of associated mind maps

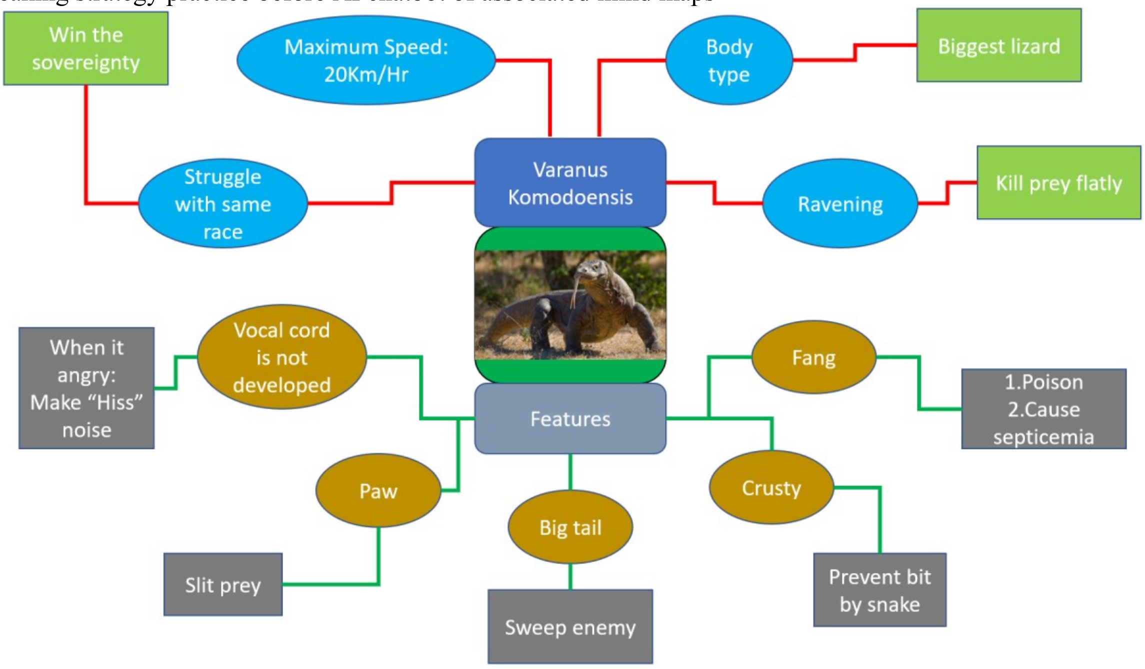

Figure 13. Student’s mind-map 1 in the experimental group

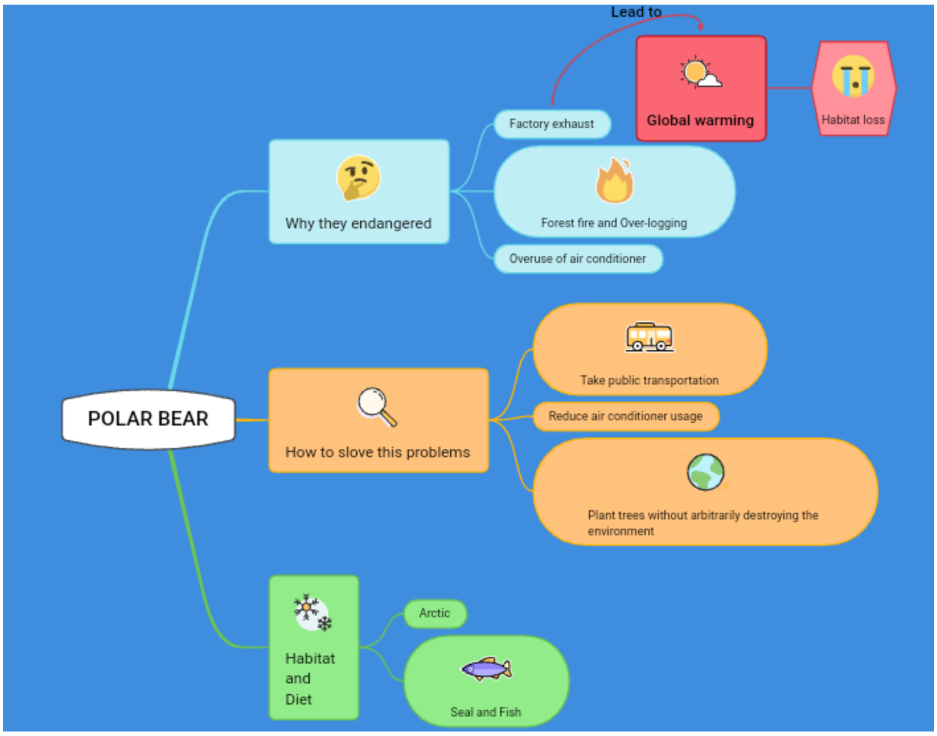

Figure 14. Student's mind-map 2 in the experimental group

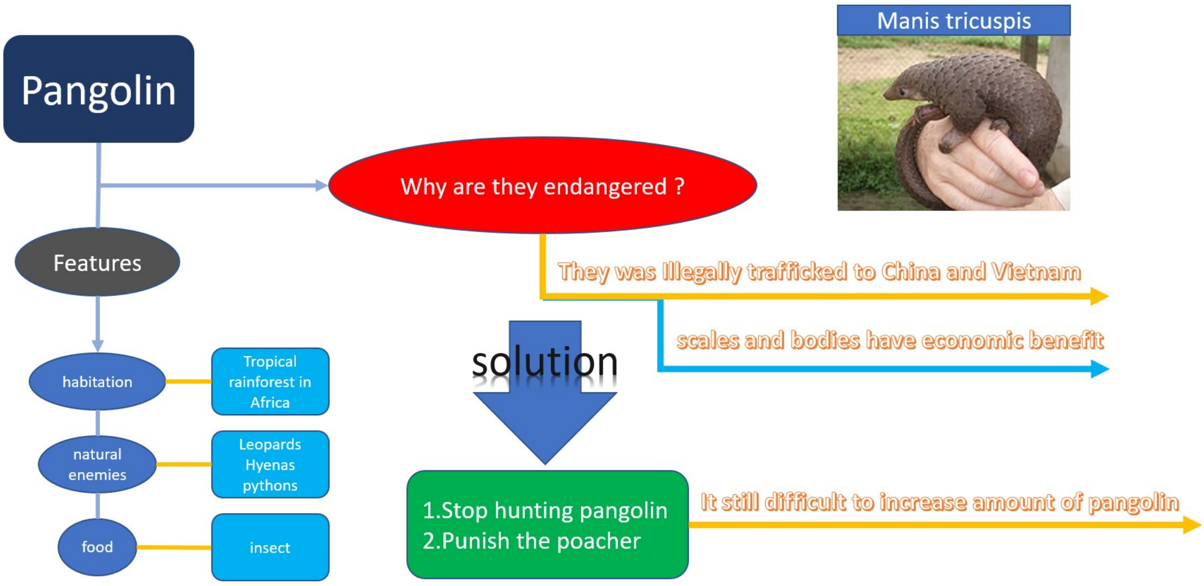

Figure 15. Student's mind-map 3 in the experimental group

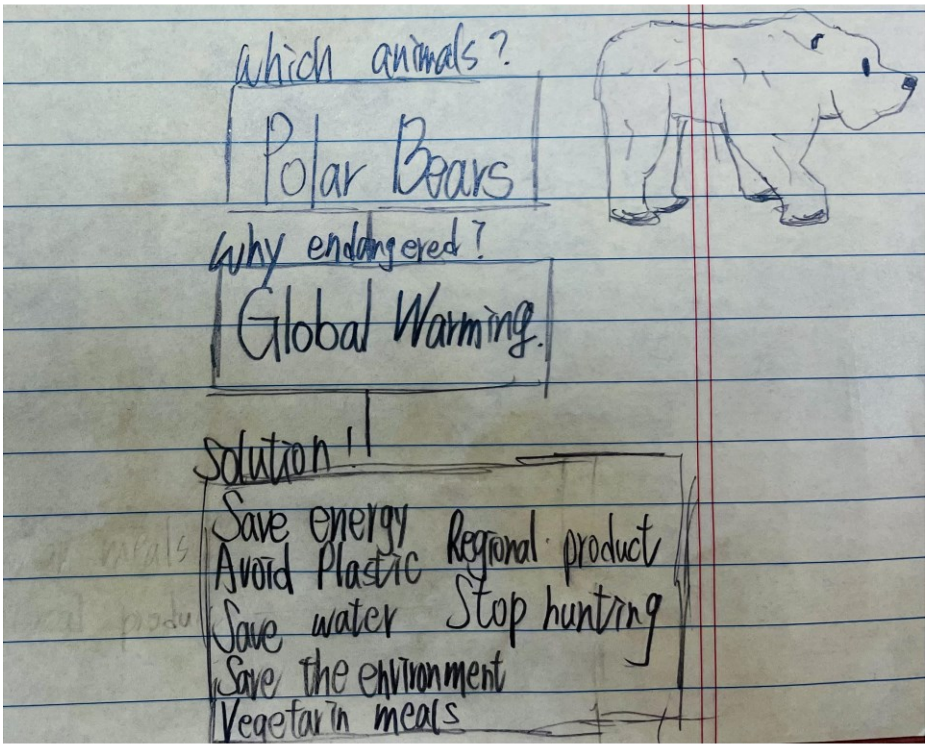

Figure 16. Mind map worksheet in the control group