A Study of the Effectiveness of English Speaking of Teachable Agent using AI Chatbot

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Abstract: In an environment where English is a foreign language (English as a foreign language: EFL), English learners use AI voice chatbots for English-speaking practice activities. They enhance their speaking motivation and provide opportunities for communication practice, ultimately leading to English language learning. It can improve their speaking skills. However, if they are preschoolers or elementary school students with no experience learning English, a conversation may not be possible using the AI voice chatbot system. In this study, we propose a teachable agent using an AI voice chatbot that can be easily used even for elementary school students and can enhance the learning effect. The existing Teachable Agent is a method that makes inferences with the knowledge acquired from the learner and answers questions using a path search algorithm. However, applying the Teachable Agent system to language learning is complex, an activity based on tense, context, and memory. This paper proposed a new TA method by reflecting the learner's English pronunciation and level to the teachable agent and generating the agent's answer according to the learner's error. Moreover, a teachable Agent AI chatbot prototype was implemented with an AI voice chatbot.

1 INTRODUCTION

In an environment where English is a foreign language (EFL), learners do not have or lack opportunities to use English in daily communication and feel psychological pressure to speak English. Recently, various IT technologies and pedagogical theories have been combined. In an environment where English is a foreign language (EFL), learners do not have or lack opportunities to use English in daily communication and feel psychological pressure to speak English. And research is actively conducted to overcome these environmental factors and increase the learning effect. There are cases of applying AI voice chatbot as an educational engineering tool in the English education field (Sung, M.C., 2020).

It has been found that when AI voice chatbot is used for English-speaking practice activities. It is possible to provide optimized learning to individual learners, increase learners' motivation to speak, and provide opportunities for communication practice, ultimately improving their English-speaking ability (Hwang, Yohan & Lee, Hyejin., 2021).

However, various problems exist, such as AI chatbots' recognition rate, ambiguous learners' pronunciation, and lack of target expression learning (Chu, S. Y., 2021).

Among them, an AI voice chatbot is a system-driven program in which learners conduct conversations as guided by the voice bot, and it is difficult for learners who need to be fluent in English. If the learner is a preschooler or elementary school student, a conversation may not be possible using the AI voice chatbot system. Therefore, in this study, we will propose an AI voice chatbot that can be easily used by preschoolers or elementary school students and can increase the learning effect.

The teaching method is one of the more effective approaches to learning as part of the Learning-by-teaching method. In a virtual environment, the learner plays an active role by teaching a computer agent called the Teachable Agent (Sandra Y. Okita and Daniel L. Schwartz, 2013).

The teaching activities in the teachable agent method allow the instructor to understand and master the primary learning content more thoroughly. As repeated training entails analyzing and elaborating the learning content from various perspectives, in-depth learning occurs through the teaching process.

The most representative Teachable Agent is

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Betty's Brain. Betty's Brain is a software environment created by the Teachable Agents Group at Vanderbilt University to help students advance their understanding of metacognitive technologies and enrich their ecosystem knowledge as part of their science curriculum.

They compared the results of studying in two ways: second-year middle school students learn biology through software and learn it on their own and teach it to a program called 'Betty's Brain'. As a result, it was found that students study longer when trying to teach software than when studying for themselves (Kittaya Leelawong & Gautam Biswas, 2008), (Taylor, R.P(Ed),1980), (Gautam Biswas1 & James R. Segedy1 & Kritya Bunchongchit, 2015).

It enables students to learn about science concepts by implementing a learning-by-teaching paradigm. In teaching Betty, a virtual student, and testing whether Betty has learned well, learners can check how much they know the concept. It has been limited to research teaching somewhat limited topics (such as conceptual learning areas of the curriculum) to Teachable Agents. At the heart of these Teachable Agents is the concept map approach, that learners teach the Teachable Agents by drawing and editing concept maps to create information structures, allowing learners to learn concepts related to data or science, such as causal impacts (e.g., ecosystems, climate change or temperature regulation). Because English learning is based on tense, memory, and context, not concepts or causal relationships, it is impossible to learn using the concept map method (Lee Ingu, 2022) (Nalin Chhibber, 2019) (Gautam Biswas, Krittaya Leelawong , Daniel Schwartz , Nancy Vye, 2005).

Language learning should be able to provide communicative practice close to an actual conversation through the steps of presentation of the expression to be learned and repeated practice. It should provide an opportunity for learners to correct errors on their own, induce them to use various expressions, and learn discourse skills.

This study applies the Teachable Agent system to language learning, an activity based on tense, context, and memory rather than simple one-to-one correspondence knowledge.

A new Teachable Agent method was proposed by reflecting the learner's English pronunciation and level to the teachable agent and generating the agent's answer according to the learner's error. And the Teachable Agent AI chatbot prototype was implemented.

2 TEACHABLE AGENT MODEL DESIGN

2.1 Overall Structure of the System

For learners to learn English using artificial intelligence (AI) voice chatbots, Learners must have sufficient communication skills to communicate in English. Non-native languages, especially when using AI chatbot systems for preschoolers or elementary school students.

There is a limit to inducing conversations directly with young learners to make it possible for learners to practice speaking, and it is difficult for students to learn voluntarily and continuously. The student's interest in learning quickly decreases, and the learning duration is short. To compensate for these shortcomings, we designed Odinga Agent, a Teachable Agent-type AI voice chatbot prototype that allows learners to improve their skills while teaching the agent.

The overall composition of Odinga Agent is shown in Figure 1. It is designed to increase learning efficiency by implementing a character chatbot rather than a voice chatbot. As the learner's skills improve, the agent's speaking skills also improve so that free conversations such as asking or answering questions to learners are possible.

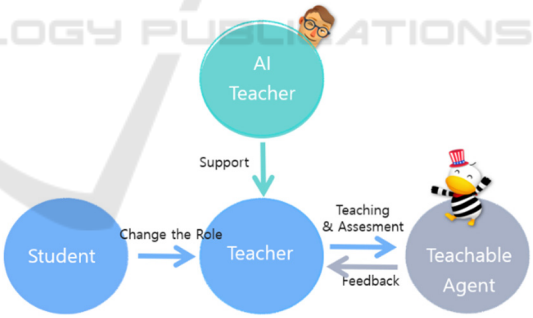

Figure 1: System configuration.

Odinga Agent consists of 4 modules, as shown in Table 1.

The Teaching Module is a module in which learners teach English to an agent. The learner speaks English first, and the agent follows along.

The Check Module is the part where the learner listens to and evaluates the agent's utterance, and the agent utters it by reflecting the learner's utterance as it is.

The reward module is a function for motivation for learning, and it provides items or coins as a reward for the behavior taught by the learner.

The Free Talking Module allows learners to talk freely with agents.

Table 1: 4 Modules of Odinga Agent.

Module	Description
Teaching Module	- Learners teach English -The learner speaks first, and the character speaks after
Check Module	-The learner evaluates the character -Reflect the learner's deficiencies in the character and make them react.
Reward Module	-The learner pays the character a reward. -Learning increases or decreases Odinga IQ and EQ. -Odinga learning ability changes according to IQ and EQ.
Free Talking Module	-The learner communicates with the character -Free conversation with characters of the same level as the learner's ability

2.2 Database for Teachable Agent

Level-specific learning contents for Odinga agents are designed to expand vocabulary and sentences and increase application power based on basic sentence patterns and sentences frequently used in English conversation. Specifically, it includes patterns and applied expressions that are essential to know at the lower grade level of elementary school students in the United States, interests of children of the same age, and topics commonly used in school. (see Fig 2).

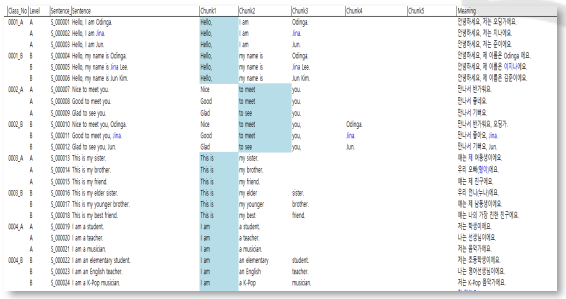

Figure 2: English Curriculums.

The automatic generation of chatbot sentences used Natural Language Processing technology, and for this purpose, 300,000 QA sets, including animation scripts, were collected. The collected sentences were labeled based on each sentence's object name recognition and intention classification results. All question and response sentences were classified into a limited number of subjects and generated composed sentences by level.

The level was set as ARI (The Automated Readability Index) Score (E.A. Smith, RJ Senter, 1967) for the written sentences. The calculation formula for level setting is the same as Equation (1).

$$\left(\frac{characters}{words}\right) + 0.5\left(\frac{words}{sentences}\right) - 21.43 \quad (1)$$

2.3 Teaching Module Design

In the Teaching Module, the learner selects a sentence to be taught to the Odinga Agent and tells the corresponding sentence. If a particular score is reached by evaluating the fluency and accuracy of the sentence, the Odinga Agent repeats the learner's utterance. If a particular score is not obtained, the Odinga Agent says, "umm.." will do. If a particular score is not reached even after repeating it three times, the doctor appears and tells the exact sentence utterance. When the first learning goal is completed, an item or coin is given as a reward.

2.4 Check Module Design

In the OX feedback system, a function for the learner to evaluate the character; if the score is less than 70 based on the learner's utterance score, the agent utters an incorrect answer. However, the incorrect answer is implemented in 3 types of 0, 1, 2, and 2 utterances in chunk units. As shown in Figure 3, the learner evaluates OX by looking at the character's answer, and if it is X, it is configured to re-utter. If the learner's incorrect answer continues, it is designed to receive help from an AI teacher called a doctor. The doctor was set to motivate learners by listening to the correct pronunciation and evaluating the learner's pronunciation. As shown in Figure 3, the learner utters up to 9 sentences while teaching Odinga Agent with a learning design to maximize the learner's speaking frequency and time.

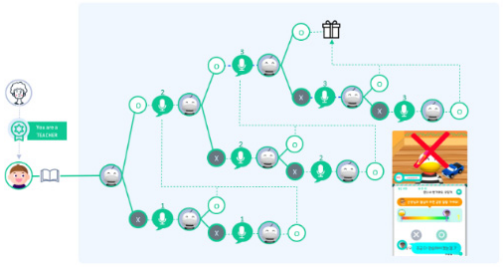

Figure 3: OX Feedback & Iterative learning system.

2.5 Free Talking Module

When a learner's English proficiency increases to a certain level, he can free-talk with an Odinga agent. As shown in Figure 4, when a learner asks a question to the Odinga agent, Odinga answers at the level of the sentence taught by the learner. If the learner asks an Odinga agent a higher-level question than the sentence taught, the Odinga agent will say, "Sorry. What was that? Teach me, please." answer and encourage the learner to teach.

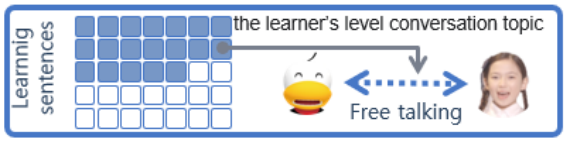

Figure 4: Free Talking Method.

3 ODINGA SYSTEM

3.1 System Configuration

As shown in Figure 5, the system configuration diagram of Odinga agent proposed in this paper has changed the function of the general AI voice chatbot's Dialogue management system to Teachable Agent.

The development environment of this service is Android Studio, and the code is written in Java. Since voice recognition and voice output should be possible, Google Speech API was used. The learner uses the Speech-To-Text (STT) API to input an English conversation for learning. The character can answer using the Text-To-Speech (TTS) API for the conversation corresponding to the input English text.

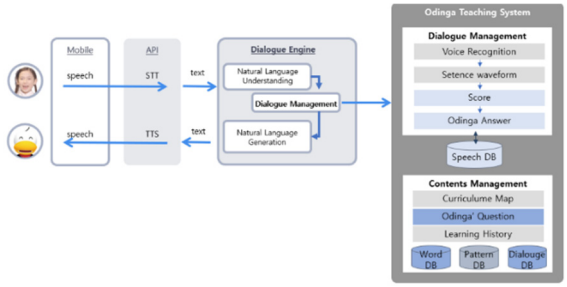

Figure 5: Odinga Agent System.

3.2 Dialogue Management System

It recognizes the learner's speech and converts it into text through STT, creates a sentence waveform, as shown in Figure 6, and creates the speech waveform of the Odinga Agent in conjunction with the learner's waveform.

The learner's utterance is calculated as a learner's confidence and similarity score. This score is applied as a weight according to the learner's IQ/EQ to motivate learning.

According to the learner's utterance score, the Odinga Agent's correct/incorrect answer is determined, and the weak part of the learner is created as the Odinga Agent's incorrect answer.

3.3 Agent Emotion Function

The EQ system with game elements was designed to generate interest continuously and form bonds through intellectual growth and the emotional expression of learners and characters. The IQ & EQ system set Odinga Agent's IQ to increase and EQ to decrease as practice continued, and the learner provided snacks and gifts to the Odinga Agent with coins acquired through learning so that the EQ could be increased.

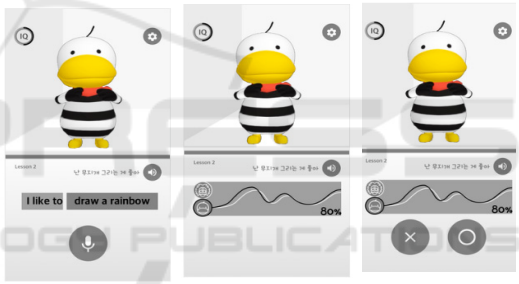

Figure 6: Agent Feedback.

IQ means the learning level of the Odinga Agent, EQ represents the emotions of the Odinga Agent, and IQ does not rise or decrease as learning progresses. EQ randomly decreases as learning progresses and increases with items, games, and emotional exchanges. If the EQ is low, Odinga will refuse to learn or make mistakes frequently during learning. In addition, as shown in Figure 7, a reaction according to the learner's utterance was implemented to add visual interest.

Figure 7: Agent Reactions.

4 LEARNING EFFECTIVENESS EVALUATION

4.1 Method

To verify this effectiveness, we evaluated Odinga Agent satisfaction for teachers and elementary school students. The subjects who participated in the evaluation were five English teachers of elementary schools and 30 students from 3rd grade to 6th grade, ten each for upper, middle, and lower English proficiency.

The first questionnaire was an English teacher group, and the functionality, persistence, and satisfaction of the Odinga agent were evaluated on a 5-point Likert scale. The questionnaire items are shown in Table 2.

Table 2: Teachers' Survey Questions.

Category	Question
Efficiency	Is it acceptable to understand learners' pronunciation and expression?
Sustainability	Do students continue to use it?
Satisfaction	Do the students find it exciting and fun?

The second survey was conducted with a student group. The students used the Odinga Agent in class for 40 minutes once a week for 16 weeks, they conducted a 5-point satisfaction measurement for the survey items. The survey items are shown in Table 3.

Table 3: Students' Survey Questions.

Category	Question
Efficiency	Does Odinga understand what I say in English?
	Will the doctor correct me if I speak English incorrectly?
Sustainability	Do you plan to continue using Odinga?
Satisfaction	Is it fun to study English using Odinga?
Study Time	How much time does it take to study with Odinga?

4.2 Results

4.2.1 Comparison of Responses Between Groups

As for the evaluation results by groups for Odinga Agent, the teacher group showed higher satisfaction than the student group in all three items.

In the evaluation items, both teachers and students showed the highest intention to continue using it and showed low scores for satisfaction. (see Fig. 8).

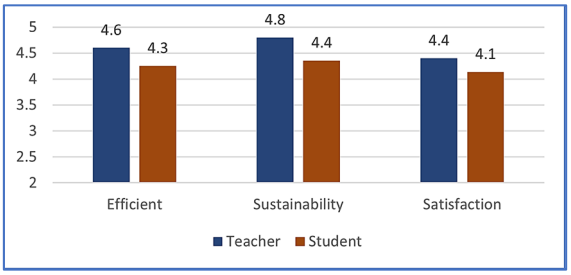

Figure 8: Comparison by Question.

As for the overall average, satisfaction was shown in the order of teachers > 4th grade > 3rd and 5th grade > 6th grade (see Fig. 9).

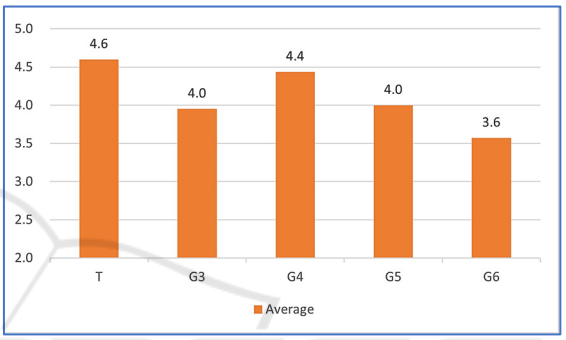

Figure 9: Comparison by Group.

4.2.2 Comparison of Responses by Question

In the Efficient evaluation, the teacher and 4th grade scored 4.6 points and 4.7 points, respectively. 6th grade showed the lowest evaluation. (see Fig. 10).

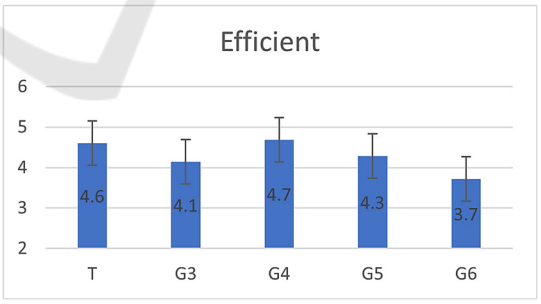

Figure 10: Result of efficient.

In the sustainability evaluation of the intention to continue using Odinga Agent, teachers and 4th graders showed high scores, and 3rd graders had the lowest evaluation (see Fig. 11).

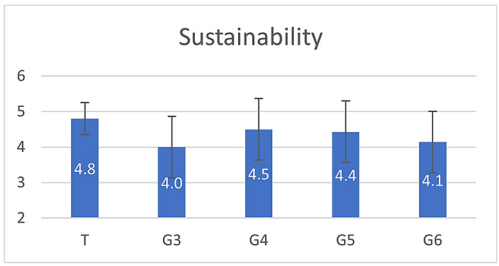

Figure 11: Result of Sustainability.

In the satisfaction evaluation of whether to continue using the Odinga Agent when learning English, teachers and students were satisfied primarily with similar scores (see Fig.12).

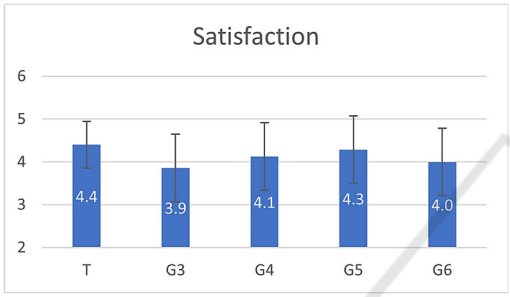

Figure 12: Result of Satisfaction.

4.2.3 Comparison of Responses by English Level

In the case of the student group, when compared by English proficiency, the functional evaluation was highest in the upper group at 4.3, the sustainability evaluation was highest in the middle group at 4.5, and the satisfaction evaluation was highest in the lower group at 4.2(see Fig.13).

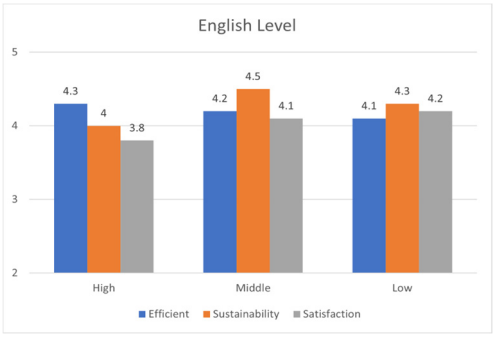

Figure 13: Result of English level.

4.2.4 Overall Results

In the evaluation of Odinga Agent, teachers' evaluation was somewhat higher than that of students. This result is because using the Odinga Agent allowed English teachers to solve the difficulties they felt in the English-speaking class.

Students in the 4th grade who spent the longest time using Odinga Agent showed high overall evaluation. According to these results, the learning effect appears only when a certain amount of learning time is secured according to the characteristics of language learning.

The reason for the lower satisfaction of the 3rd graders compared to the 4th graders seems to be that they had difficulties in teaching English because the difficulty of English sentences was somewhat higher than their level (see Fig.14).

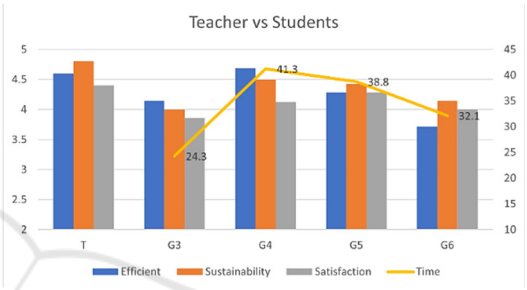

Figure 14: Total Result.

The difficulty of English sentences needs to be adjusted through the verification of the ARI index and the verification of English experts.

5 CONCLUSIONS

This study designed a teaching-type AI chatbot Teachable Agent to activate personalized, level-specific education and maximize learning effects in English education.

This system is a Teachable Agent AI chatbot that improves the speaking ability of the agent as the learner's skill improves. It was designed to increase learning efficiency by implementing a character chatbot rather than a voice chatbot to escape the boredom of repeated learning and to make it more like a human conversational environment. As the learner's skill improves, the agent's speaking ability also increases, so free conversations such as asking or answering questions to the learner are possible. It was designed to increase learning efficiency by implementing a character chatbot rather than a voice chatbot to escape the boredom of repeated learning and to make it more like a human conversational environment.

In addition, usability evaluation was conducted

for actual elementary school English teachers and elementary school students, and the effectiveness of the Teachable Agent AI chatbot was evaluated.

This study is to verify whether it is possible to apply the Teachable Agent function to the AI voice chatbot. It can be applied to motivate students or preschoolers who are not interested in learning through role switching to participate voluntarily in learning.

It is possible to improve the immersion of the educational effect by allowing children to practice conversation or conversation using their favorite character as a model.

In the future, it is necessary to evaluate the effectiveness of the proposed system in more detail by comparing it with the AI voice chatbot used in the existing English education field.

ACKNOWLEDGMENT

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