

Using Tangible Companions for Enhancing Learning English Conversation

Yi Hsuan Wang, Shelley S.-C. Young* and Jyh-Shing Roger Jang

National Tsing Hua University, No.101 Section 2 Kuang-Fu Road, Hsinchu City, Taiwan 300 //

annywang12345@hotmail.com // scy@mx.nthu.edu.tw // jang@cs.nthu.edu.tw

*Corresponding author

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ABSTRACT

In this study, the researchers attempted to extend the concept of learning companions from the virtual world to the real physical environment and made a breakthrough in technique development of tangible learning robots. The aim of this study was to explore an innovative way by combining the speech recognition technology with educational robots in the hope that the state-of-the-art technology could provide learners with more opportunities of bi-directional language learning in the English class settings. The quasi-experimental design was adopted in this study and a total of 63 Taiwanese students in the fifth grade participated in the experiment. The results reveal that using the tangible learning companions in learning had positive effects on learners' learning motivation, confidence and engagement especially for the lower-achievement learners. Two learning methods were identified in the study, co-discovery and peer tutoring method. The co-discovery method enhanced the lower-achievement learners' learning involvement and their English speaking ability. Students perceived the tangible learning robots as friendly learning toys or even like a patient instructor for practicing English conversation. Both English instructor and students agreed that uses of the tangible learning companions effectively improved the class atmosphere, and raised their and positive attitude toward learning English.

Keywords

Learning companions, English learning, Tangible technology, Speech recognition, Elementary education

Introduction

English has been an important learning subject in formal education in Taiwan. However, some issues have been observed in English learning and teaching contexts. For example, while students generally are good at reading they do not feel comfortable with speaking. The beginning English learners in specific often feel shy and embarrassed practicing English conversation with a teacher or peer learners because of the fear of making mistakes (Pan, 2001). Furthermore, some learners, particularly the low-achievement ones, often feel uncomfortable speaking English in front of other students or teachers due to the fear of making mistakes. In the long run, they might lose the interest and confidence in learning English. Additionally, it is difficult for teachers to provide every student with equal opportunity of practicing English conversation in the regular classroom and it is also difficult for learners to find partners to practice English speaking together at home due to many newlyweds in Taiwan prefer to have one child only (Chen, 2011). However, the advantages of the developing learning technology could help instructors solve the problems that students meet. Educational learning companions have attracted a great deal of attention in the field of technology enhanced learning. The human-like characteristics enhance students' attention and confidence in learning subjects (Chen, Liao, Chien, Chan, 2011). Nevertheless, most of the existing learning companions are presented in the web-based environment which could only interact with learners on the flat screen. Few studies have been conducted with a focus on physical and tangible companions, particularly those designed to integrate learning companions into the formal English language settings.

On the other hand, the applications of portable robots, physical and tangible learning companions are the interesting topics which catch researchers' interests in recent decades. The characteristics of multiple learning interactions through both visual stimulation and tangible sense benefits learners especially for young children (Xu, Read, Sim & McManus, 2009). Hence, with the idea of combining the learning companions with tangible technology in mind, the researchers extended the concept of learning companions (Chan & Bsdkin, 1988) from virtual world to real world and started from the viewpoint of bettering language learning. Therefore, both the Learning Technology Lab and Multimedia Information Retrieval Lab at National Tsing Hua University, Taiwan, have made a joint effort in associating instructional technology with the advanced speech recognition techniques to develop innovative tangible learning companions in the appearances of popular cartoon characters, which could play the role as the interactive English learning partners in English classrooms.

The study proposes the pedagogical activities and implements the tangible learning companions in the English class settings using the state-of-the-art technology, speech recognition technology, to help improve the practices of learning English conversations. We aim to investigate the pedagogical strategies of using learning companions in classroom settings and evaluate elementary students' learning motivation, performance and perception toward the uses of learning companions.

Research questions

The research questions of this study are as follows:

1. What were the students and instructor's feedback and perception toward applying the learning companions in English classes?
2. How did students' learning process, attitude, effectiveness changed and enhanced with the uses of learning companions in English class? What role would the tangible learning companions play in learning English? Would the tangible learning companions make the classroom atmosphere differently?
3. What learning methods did learners use when they practiced English conversation with the tangible learning companions in groups?

Literature review

Tangible learning companions

Computers as the learning companions could act as learning partners, peer-learners and tutors which help or instruct learners in learning (Chan & Bsdkin, 1988). Research has indicated that using learning companions in learning can strengthen learners' motivation, engagement and concentration and also exert positive learning effects on learners (Chen et al., 2011). For example, My-Mini-Pet system (Liao, Chen, Cheng, Chen, Chan, 2011) is a handheld animal companion learning environment which applies three strategies, pet-nurturing, pet appearance-changing and pet feedback, to encourage students to engage in the learning activities. Another similar application of virtual learning companions is My-Pet v2 system (Chen, Liao, Chien, Chan, 2011). It consisted of three learning flows, nursing phase, learning phase and competition phase, to enhance learners' attention, relevance, confidence and satisfaction while learning. A study compared different kinds of learning media, including real instructors, robots and tape recorders, in learning new things for children; the results showed that learners paid most attention to human instructors, then moving robots and least attention to tape recorders (Draper & Clayton, 1992). It is likely that these learning companions impose different impacts on learners. For instance, virtual learning companions such as agents have been found to allow learners to get familiar with learning environment quickly (Chalfoun & Frasson, 2008). Moreover, robots, physical learning companions, have been found to enhance children's motivation and provide learners with multiple learning interactions through both visual stimulation and tangible sense (Hsu et al., 2007).

Tangible technology has been introduced in the 1990s. The potential of tangible user interface is that it can transform digital information to physical learning objects and it is an appealing learning method with actual operation for younger learners (Xu, Read, Sim & McManus, 2009). Tangible technology can be used for trial-and-error activities and more than one user can be involved at one time (Hall, 2009). The characteristics of tangible technology help learners acquire knowledge easily and obtain special concepts to enhance learning (Ullmer & Ishii, 2001). Besides, researchers (Lou, Abrami & Apollonia, 2001) have pointed out that applying the small group learning strategy can benefit learners and have significantly positive effects than individual learning on student individual achievement when using learning technology in learning. As a result, we combine the idea of learning companions and tangible technology together and apply the small group learning strategy to implement the tangible interactive learning companions enhance English learning in English class. It is our intention that the tangible learning companions can act as a friend, peer learner, tutor in group with which learners can interact.

English learning & scaffolding strategy

In Taiwan, it is a challenge for the beginners to overcome the psychological barrier of learning English, especially spoken English. Most of the students are afraid of speaking due to the language ego and they are afraid of making

mistakes in front of the teacher and the other classmates (Guiora, Brannon & Dull, 1972). Research indicates that the scaffolding strategy could promote positive learning experiences for students and the scaffold instruction is the most efficient way of helping learners being familiar with the learning contents and learning skills (Lutz, Guthrie & Davis, 2006). Besides, the affective filter hypothesis states that whether learners can learn a language effectively is related to emotional factors including motivation, self-confidence and anxiety. In this case, it is important that instructors or parents create an enjoyable learning atmosphere for efficient English learning. The guideline of *audio-lingual method* (ALM) also points out that instructors should give examples of English sentences for learners so that they can practice them repeatedly until they can use them in natural communication (Richards & Rodgers, 1986). The goal of this study is based on the concept of scaffolding learning. It aims to encourage students speak English and make learners more comfortable and enjoyable in learning with tangible learning companions in a low-anxiety classroom atmosphere, and the ALM is used as the interactive design guideline for the interaction between learners and tangible learning companions. Learners therefore could learn comprehensively through repeated practices.

Speech recognition

The process of speech recognition includes front-end processing, linguistic decoding and artificial neural network (Neumeyer, Franco, Weintraub, & Price, 1996). Learners receive immediate feedback as they input voice to the systems or computers. With the aid of speech recognition techniques, learners are offered with interactive and varying learning opportunities of practicing English communication, compared to the traditional teaching and learning method in which tape recorders are used in the classroom. For the last decades, the application of speech recognition technology has been used in the field of *Computer Assisted Language Learning* (CALL). For example, a computer-based speech recognition system, CANDLE, was developed for helping Taiwanese college students enhancing their English pronunciation (Chiu, Liou & Yeh 2007), and another CALL system, ILLSE, which integrated the technique of Text-to-Speech function has been proven to facilitate high school students' English speaking ability (Tsai, 2011).

Importantly, there are several arduous tasks in applying speech recognition, the accuracy of rate, the size of voice database (Chu, 2005) and the corrective feedback from CALL system (Chen, 2011). A person's speech tone is highly unique, and it is difficult to recognize everyone's speech accurately and provide students with corrective feedback for indicating their language errors. For this reason, a large speech database and feedback library is needed to increase the accuracy of speech recognition and store the suitable feedback for learners. However, setting up such a database is a highly time-consuming and demanding mission. To improve better recognition accuracy, the learning materials should be defined closely so as to limit the range and variation of utterances. Noticeable, the previous study was constrained in the computer-based environment (Chan, 2011). However, in this study, we did a breakthrough in technique development by combining the speech recognition technology with tangible educational robots and extended the application of speech recognition technology from the computer screens to the tangible learning devices so as to provide learners with flexibility, mobility and opportunities of bi-directional language learning.

About the tangible learning companions and developed tools

The tangible learning companions have been developed on the concept of ALM and they are set as the initial-scaffolding roles as well as motivating and patient learning partners for English beginners to practice conversation.

With the embedded speech recognition technology, the tangible talking robots bearing the functions of bi-directional conversation are actualized. The tangible learning companions could automatically respond to learners' utterances within 0.5 seconds. We used the 16-bit micro-controller SPCE061A for voice corpus collection and speech recognition. Two pieces of software, VSTAR Modeler (Bailey, 2006) and U'nSP IDE developed by the Cyberon Corporation and Sunplus Technology Company have been used for acoustic model training and integration tools. *Hidden Markov Model* (HMM) has been used as the sequence-based classifier for speech recognition (Baum & Petrie, 1966). Basically, we need to collect an English speech corpus of children and the corresponding transcriptions for training HMM based on the principal of maximum likelihood estimate. Due to the limited computing power of the micro-controller, the speech feature is based on 26-dimension of Mel-scale Frequency Cepstral Coefficients (MFCC) and its derivative, and the HMM is based on the monophone. The recognition part is based on Viterbi decoding using linear lexicon networks, and the sentence with the maximum log likelihood (greater than a given

threshold) is output as the predicted answer. Then one of the possibility response utterances corresponding to the predicted answer was selected randomly and played back as the learning feedback to the learner (Figure 1-1 & 1-2). According to our test, the recognition accuracy is about 92.5% under a normal quiet office environment. This means the tangible learning companions can answer learners correctly about nine times out of ten.

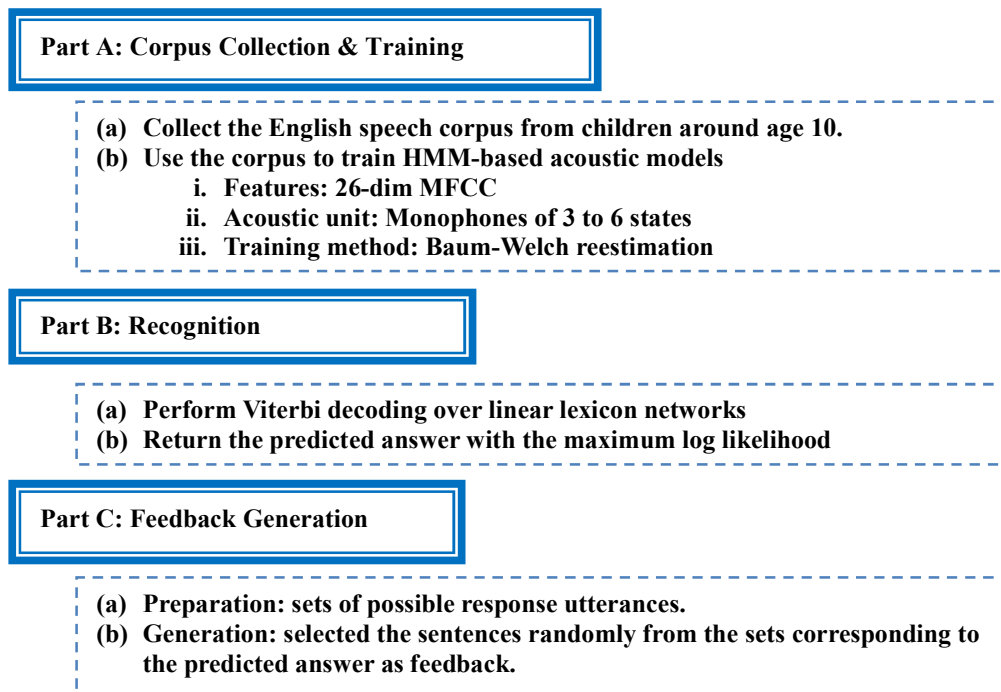


Figure 1-1. Description of the speech recognizer

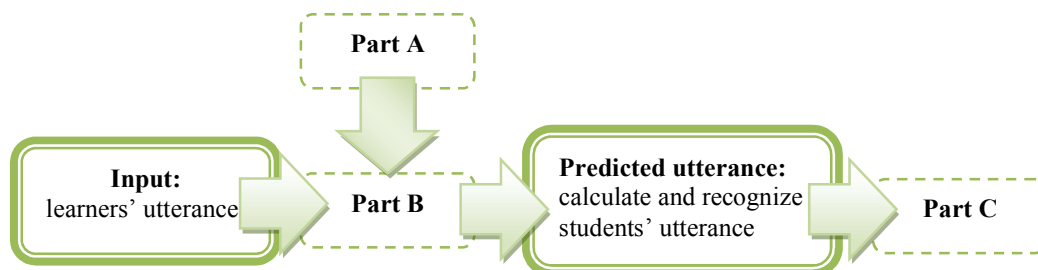


Figure 1-2. Description of the speech recognizer process

The tangible learning companions were created in the shape of the cartoon figures based on the results of our prior study (Young, Wang & Jang, 2010) (Figure 2-1). In addition, the learning companions could act out and move while interacting with the learners in English conversations, including singing English songs, walking forward and flapping wings, etc.



Figure 2-1. The appearances of the tangible learning companions

Basic English learning materials were used for the beginners in this study, including Greetings conversation, Self introduction and Good-bye conversation, etc. Learners could practice the sentences out loudly to the tangible learning companions and they would get immediate accurate oral responses from the tangible learning companions as if the learners were conversing English with a real partner or a teacher. Figure 2-2 shows the example of Greeting conversation and the framework of learning processes between learners and learning companions.

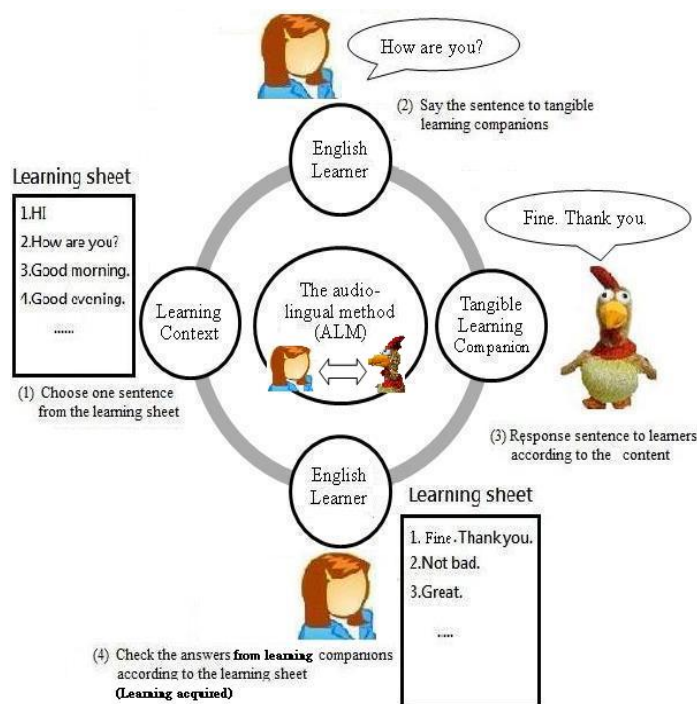


Figure 2-2. The framework of learning processes

Methodology

The quasi-experimental design was adopted in this study. The study used comparative test data and empirical experiments to report on the performance of learning English with and without the tangible learning companions. Both qualitative and quantitative data were collected and analyzed. The triangulation was used to improve the probability so that findings and interpretations could be reliable. Observation forms detailing students' learning performance in English class were recorded by five observers who were graduate students majored in e-learning technology. The observational scales were documented in the observation forms. More specifically, before the experiment, all the five observers were trained for how to categorize students' learning behaviors and the interaction processes with the tangible learning companions and with peers. The content of the evaluation criteria included: did students pay attention to English teachers' instruction; did they engage in the speaking activity with peers and learning companions, and when would students show stronger learning motivation in learning and what might be the reasons or factors to affect this situation etc. Besides, how students' learning involvement and emotion changed during the practice session were also video recorded. To understand the learning effectiveness, learners were required to do both the pre-test and post-test. The contents of the test were developed based on the specific English courseware and discussed with the targeted English teacher. Furthermore, a questionnaire that contains a five-point Likert scale was used to collect learners' attitudes of using the tangible learning companions. Researchers designed the questionnaire and evaluated students' learning performance according to the scales from "Measuring Children's Fun" questionnaire (Read, MacFralane & Casey, 2001). Learners' motivation, self-confidence and anxiety toward learning English conversation with and without the tangible learning companions were observed. Moreover, their learning durability, engagement and expectation of using tangible learning companions in learning English were also evaluated. In addition, both individual and focus group interviews were conducted.

Participants

A total of 63 fifth graders from two classes of an elementary school of Taiwan participated in this study. Class A was the experimental group that contained 32 learners. In Class A, the tangible learning companions were employed for the students to practice English conversations. Class B was the control group that consisted of 31 students in which the traditional learning method was applied and the students practiced English conversations with their classmates. Learners in both classes were further divided into five subgroups based on their English grades earned in the previous semester. The high-achievement learners were the students whose grades were at the top one third of the class. The grades of low-achievement learners were at the bottom one third of the class. Each subgroup consisted of six to seven students, including high, medium and low-achievement learners.

Data collection

The tangible learning companions were integrated into the class when students were learning English conversations in the Spring semester in 2009. Before the class, learners are required do a pre-test and post-test before and after the class, including the English writing and speaking tests. To assess their writing ability, learners had to take a cloze and pair tests. To evaluate their speaking ability, they were tested on a short English conversation. Five trained English teaching assistants played the role of evaluators to grade students' speaking performance. The rubrics used in the speaking test included two parts: learning performance and learning interaction. For the rubrics of learning performance, the speaking speed and pronunciation were evaluated. For the rubric of learning interaction, were learners confident while uttering the sentences, were they nervous while doing the test, and other reaction of their learning attitude were evaluated. The testing items were five basic English conversation such as "What color do you like?" and "Where do you live?" etc. During the class, the instructor led the learners to practice each sentence in groups. The students in the class A had English interactions with the tangible learning companions. For example, when learners asked a learning companion about its name (What is your name?) and the learning companion would reply to learners automatically. After the interaction sessions, every subgroup in the experimental group was further interviewed for their reflections on using the tangible learning companions for practicing English conversation.

Data analysis

The study applied the triangulation method for data collection and analysis. Following the research questions, the researchers analyzed and reported the study results from pre-test and post-test, questionnaires, classroom observations and interviews. Both of the Independent Samples T-test and Paired Samples T-test were applied for the statistic analysis. Besides, the reliability of the questionnaire was measured with the SPSS software and the Cronbach's α was applied to examine the consistency between each items. The score of Cronbach's α of the questionnaire was 0.874 and the reliability of the questionnaire was achieved. Moreover, the original class observations and interviews were transcribed verbally then coded and reduced them into several scales according to the themes which included the interaction processes with peers and with learning companions, the engagement and concentration during the practice time, and the reflections and attitude toward learning English with the tangible learning companions.

Students' and the instructors' feedback and perception on using tangible learning companions

Students' evaluation on the usability of the learning companion was measured after the English classes. Data related to usability from the questionnaire are shown in Table 1. Students suggested that the learning companions were easy to use and that they experienced no difficulty at operating them. Moreover, the pronunciation of the learning companions was clear and the volume was adequate. Most of the learners liked the appearances of the tangible learning companions. Besides, from the open-ended questions and interview feedback, students reflected that the immediate response from the learning companions made students feel like having a real conversation with teachers. Most of them had positive feedback after using the tangible learning companions in learning English conversation. Moreover, they also indicated that they would like to have a friend like the learning companions used in this study in other learning subjects that they take.

The instructor also showed positive attitude toward using tangible learning companions as a teaching assistant in the English classes. He commented that adopting the tangible learning companions in class gave learners more opportunities to practice English conversation and motivated them to speak out the English sentences bravely compared to the English class before.

Table 1. The questionnaire of usability feedback

Item	Statement	1	2	3	4	5	Mean
Q1	I have some troubles in using tangible learning companions.	25.8%	9.7%	45.2%	12.9%	6.5%	2.64
Q2	It takes lots of time to learn how to interact with tangible learning companions.	16.1%	12.9%	61.3%	6.5%	3.2%	2.67
Q3	The pronunciation of the tangible learning companions is clear.	6.5%	12.9%	32.3%	12.9%	36%	3.58
Q4	The appearances of tangible learning companions are attractive to me.	6.5%	0%	25.8%	16.1%	51.6%	4.06
Q10	I want to have one friend like the learning companion in learning English with me.	3.6%	0%	7.9%	14.3%	64.3%	4.35
Q11	I enjoy learning and feel comfortable to practice English with learning companions.	3.6%	3.6%	14.3%	10.7%	67.9%	4.35

Note. 5 to 1 points: strongly agree, agree, neutral, disagree, and strongly disagree.

Learning process, motivation, attitude and classroom atmosphere of using tangible learning companions

The *Experimental Group* (E.G.), *Control Group* (C.G.) and each small subgroup were observed by trained assistants and tap-recorded learners' interactions in both groups during the instruction and subgroup practicing time. Observation data indicate that learners in E.G. displayed much higher learning concentration and engagement with learning material than those in C.G. during the instruction time (Figure 3). Later in the subgroup practicing time, the learners in each subgroup of E.G. were also highly interested in practicing English conversations with the other classmates and the tangible learning companions. Not only did they show higher motivation in practicing English with the tangible companions but they also tried to listen very carefully to the other students who were practicing conversation with the learning companions (Figure 3A).

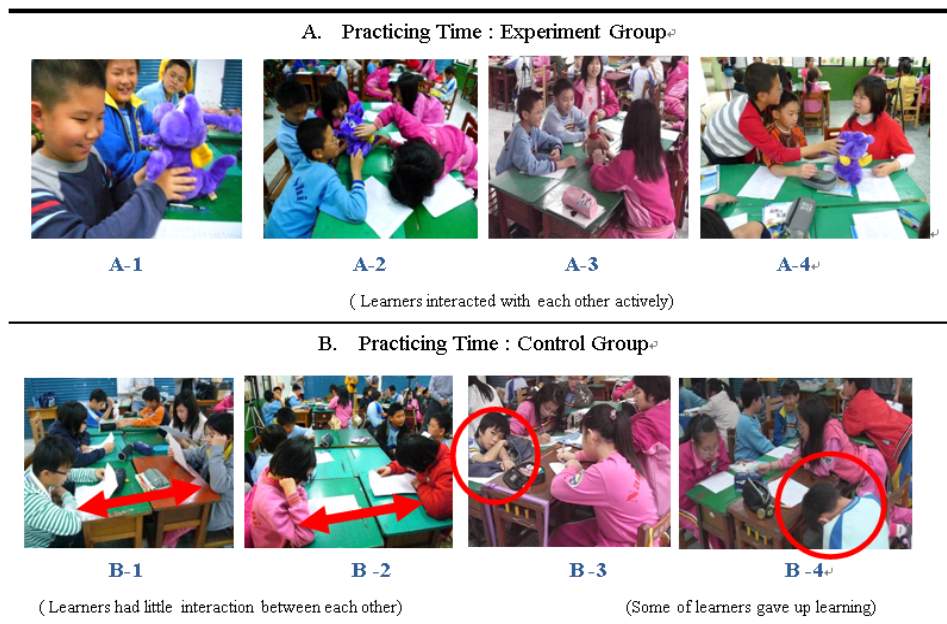


Figure 3. Comparison of the two groups

The results of the questionnaires (Table 2) show that the E.G. had more positive attitude, motivation and confidence in learning English than those in C.G. and learners in E.G. had little anxiety when practicing English with the tangible learning companions than those in C.G.. Students were eager to learn the conversation and dared to ask more questions about how to improve their pronunciation of each English sentence. Besides, some positive comments were given from learners such as they felt comfortable with practicing English with the tangible learning companions and that talking with learning companions is like with a real friend and the atmosphere in the classroom was vigorous and vivid than before (Table 3).

The atmosphere of the class was full of joy in E.G.. English instructor had difficulty managing the class in order due to the students' higher motivation and lower anxiety. In addition, trial and error learning was also observed in the group practicing time (Xu, 2009). Contrary to those in the E.G., learners in the C.G. were well-behaved and orderly but their motivation and engagement in learning were not as strong as those in the E.G.. They had little interaction with group members and were easily distracted (Figure 3B). Furthermore, when we focused on the analysis of low-achievement learners in C.G., we found that some of them even gave up learning due to frustration. This situation could be worse in the group practicing time, as the low-achievement learners had nothing to do and felt bored when other students were practicing English conversation in pairs (Figure 3B-3 & B-4).

Table 2. Part of the questionnaire of attitude (motivation, confidence, and anxiety)

Item	Statement	Group	Mean	T	P
Q1_1	I enjoy the way of practicing English in today's class.	E.G.	4.46	2.37	.01
		C.G.	3.83		
Q1_6	I dare to speak English with my classmates loudly after today's practicing activity.	E.G.	3.63	1.67	.038
		C.G.	3.03		
Q1_8	I am still afraid of speaking English because I am not good at English.	E.G.	2.2	-0.21	.41
		C.G.	2.26		
Q2_1	I am willing to practice English in this way over again.	E.G.	3.9	1.42	0.07
		C.G.	3.47		
Q2_5	I feel comfortable and concentrated on the learning activity today.	E.G.	4	1.34	0.09
		C.G.	3.6		
Q2_8	I expect I could use the same way to practice and learn English in the following English class.	E.G.	4.4	2.08	0.02
		C.G.	3.8		

Table 3. The interview feedback from learners

NO.	Advantages	NO.	Things need to be improved
S_EE4	It makes me have courage to speak out the English sentences.	S_EA24	I hope Popodoo could speak loudly when he responded me.
S_CH32	I hope I could have more chances to talk with Popodoo and I felt comfortable practicing English with her because she is just a toy and I can say whatever I want with her.	S_EB25	It will be much better if it can speak more English sentences.
S_E	I feel nervous when practicing English with my teacher but relaxing when practicing with my friends and the chicken.	S_EE12	I hope it can answer me no matter what I ask him

Learning effectiveness of experiment group and control group

We compared students' learning performance between the E.G. and C.G.. Table 4 shows the results of the pre-test and post-test. According to Table 4(a), there is no significant difference in the total score of pre-tests ($t = .681, p = 0.499$) and post-tests ($t = .594, p = .227$) within both groups according to the results of Independent Sample T-test. However, noticeably, Table 4(b) indicates that according to the results of Paired Samples T-test there are significant differences between the pre-test and post-test speaking scores in the E.G. ($t = -3.78, P = 0.00$). In contrast, no obvious differences were found between the pre-test and post-test scores of the C.G. ($t = -1.58, P = 0.12$). Moreover, Table 5 indicates that the means of the post-test scores of the speaking part (Low-achievement Learner (L.L.), $M = 25.62$; High-achievement Learner (H.L.), $M = 38.67$) are higher than those of the pretest scores (L.L., $M = 20.88$;

H.L, M = 38.11) which occurred in both the low-achievement and high-achievement learners in the E.G.. Furthermore, there are also significant differences between pre-test and post-test scores from the results of Paired Sample T-test for the low-achievement learners in E.G. ($t = -2.44, P = .02$).

Table 4. The results of pre-test and post-test of both groups

Total Groups	(a) Independent Samples T-test						(b) Paired Samples T-test					
	score	Mean	S.D	F	T	P	Groups	Speaking part	Mean	S.D	T	P
Pre-test	E.G.	82.45	22.26	.60	.68	.50	E.G	Pre-test	30.72	8.76	-3.78	.00
	C.G.	78.48	22.82				Post-test	34.79	7.76			
Post-test	E.G.	84.28	23.07	1.72	.59	.23	C.G	Pre-test	27.52	11.17	-1.58	.12
	C.G.	80.39	27.32	Post-test	30.06	11.13						

Table 5. The results of speaking scores of experiment group

Speaking Part (E.G.)	Paired Samples T-test							
	Pre-test		Post-test		Pre-test – Post-test		T	P
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Low-achievement Learner (L.L.)	20.88	7.45	25.62	8.78	-5.49	-4.75	-2.44	.02
High-achievement Learner (H.L.)	38.11	1.45	38.67	3.32	-0.44	2.40	.56	.30

The learning methods of using tangible learning companions in experiment group (E.G.)

Further analysis of the E.G. was conducted. It indicates that two learning methods, co-discovery learning method and peer tutoring learning method, could be deduced from the five subgroup while students were interacting with the learning companions in the E.G..

Co-discovery learning method and Peer tutoring learning method

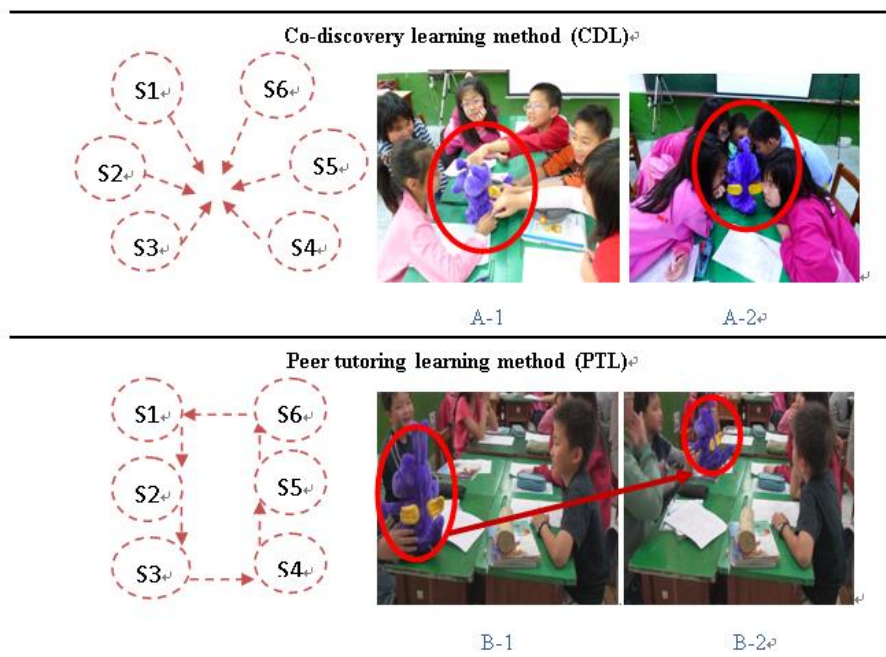


Figure 4. Two learning methods in experiment class

It was found that the *co-discovery learning method* (CDLM) was adopted by three subgroups and the peer tutoring learning method was adopted by the other two subgroups. In the subgroups in which CDLM was used (Figure 4A), learners put tangible learning companions at the center of the table and concentrated on it. Every member practiced English with the learning companion actively and exchanged the tips of how to operate it correctly. Learners were found to be enjoying practicing English conversation with the tangible learning companions. The subgroups which adopted the *peer tutoring learning method* (PTLM) had a leader to lead all of the members to take turns in practicing English conversation with the tangible learning companions (Figure 4B). Learners practiced English with learning companions one by one and the previous learner taught the next how to use it correctly.

Comparison of the two methods

The speaking scores of the high-achievement and low-achievement learners between the two subgroups of these two different methods in E.G were compared (Table 6). The results indicate that the standard deviation of the speaking grades in the post-test reduced in the CDLM subgroups. Also, the scores of low-achievement learners in those subgroups were much higher than the subgroups which using PTLM (Figure 5 & 6). Both of the low-achievement and high-achievement learners improved more at CDLM subgroup (H.L. improved 10 points and L.L. improved 15 points). Significantly, the CDLM is considered as a more effective approach in helping low-achievement learners practice English speaking because learners could have more opportunities to interact with the classmates. The finding was similar with the preview studies that the co-discovery learning method could enhance students' learning efficiency and motivation (Umar & Tatari, 2008). More detail information will be mentioned in the discussion part.

Table 6. The comparison of the two methods

		CDLM		PRLM	
		Mean	S.D	Mean	S.D
Pre-test	H.L.	28.75	1.70	36.00	3.91
	L.L	23.25	8.34	19.25	7.76
Post-test	H.L.	39.00	1.15	40.00	0.00
	L.L	38.5	7.54	25.5	8.42

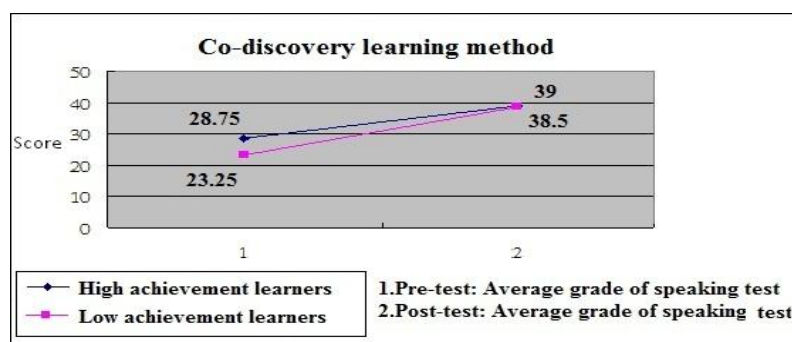


Figure 5. The comparison of the two methods: CDLM

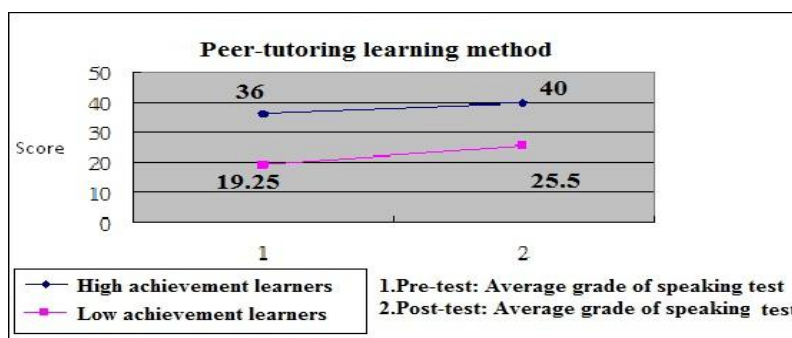


Figure 6. The comparison of the two methods: PTRM

Discussions

Tangible learning companions and learning atmosphere

The data collected from the classroom observations indicated that there was a big difference between the control and experimental groups. Obviously the students in C.G. had little interaction between each other and those students who were not good at speaking English simply gave up learning and even fell asleep in classroom (Figure 3B). However, the experiment group displayed much higher learning concentration and engagement than those in C.G. in the instructional session and subgroup practicing time. Students in the experiment group got together and formed a circle to learn English conversation through interacting with the learning robots (Figure 3A). Moreover, the data from the self-evaluation questionnaires and focus group interviews show that students revealed high interest in practicing English conversation repeatedly with the tangible learning companions. The interaction between learners was facilitated. Students commented that the learning companions were like friends and won't get angry while they did not speak English correctly so that they were not afraid of speaking English with the tangible robots. For example, student commented: *It makes me happy and the atmosphere in classroom was joyfully. We liked to talk in English much more (S_ED20).; I hope I could have more chances to talk with it (the tangible companion) and I felt comfortable practicing English with her because she is just a toy and I can say whatever I want with her (S_CH32).; I enjoy practicing English with the interactive chicken because it is a doll and it won't get angry (S_EA5).*

In addition, the results of the study support the results of the previous studies (Hall, 2009) that the trial-and-error learning approach helps learners enhance their activeness and comfortableness in practicing English conversation. The tangible learning companions play an important role in improving the atmosphere of the learning environment. In other words, the characteristics of tangible technology, binding, objects and embodiment (Ullmer & Ishii, 2001), combine the virtual concept of English learning with physical learning media. The immediate English response, the simulated appearance of human being and the movement of the tangible learning companions attracted learners' attention and interest and hence promoted the learning atmosphere in the English classroom. Learning and joyful gaming modes were blended while students interacted with the physical tangible learning companions.

Tangible learning companions and the two learning methods: Co-discovery learning method and peer-tutoring learning method

There are significant improvements between the pre-test and post-test speaking scores in the experiment group (Table 4) especially for the low-achievement learners (Table 5). Besides, it was found that learners used CDLM and PTLM methods to practice English conversation. The students in the CDLM group cooperatively exchanged the tips of how to operate tangible learning and how to pronounce each sentence correctly (Figure A). For the PTLM group, a group leader, usually the more advanced student, helped group members practice the conversation in sequence (Figure 4B). These two kinds of learning methods are similar to the method of cooperative learning conducted by Damon (1984). He observed that students adopted the peer tutoring method and co-discovery method when learning new things with each other. Related studies showed these two methods can enhance students' learning efficiency (Umar & Tatari, 2008). Our study also supports this finding. Furthermore, the data indicated that the low-achievement learners had a great improvement in speaking ability while in the CDLM group (Table 5). Two low-achievement learners in the CDLM group commented that *"I feel nervous when practicing English with my teacher but relaxing when practicing English with my friends and the chicken (S_EA5)"* and *"I like to have English conversation with classmates more than before (S_EA4)."*

Besides, the tangible learning companions played different roles in two methods. For the PTLM group, it played the role as physical peer-partners. One group leader who played the role as instructor guided the learner how to talk with the learning companions and others just watching and waiting. However, in the CDLM group, all the students paid attention on the tangible learning companions. They were looking forward to hearing the responses from the learning companions, and when it "speaks," all the students uttered and discussed in highly engagement about which sentence to practice for next, how to modify their speaking errors and even murmur on each other about the English sentences they just learned. It promotes self-directed learning and the opportunity for self-evaluation through the stimulation of the sense of touch, vision and hearing. The tangible learning companions played the role as instructors, peer-partners and opportunity providers in the CDLM group to motivate students speak out (Figure 7). No advanced leaders would "interrupt" or "guide" students how to speak. Hence, the low-achievement students overcame the learning fear

caused from language ego to actively engage in learning English and their speaking ability could be enhanced. The blending of the co-discovery learning method and tangible learning companions is considered as a more effective approach in helping low-achievement learners. In other words, the tangible nature of learning companions brings students the experiences of English speaking in the real world. The tangible companion scaffolds students to speak English and provides learners with opportunities to co-discover learning with each other in English.

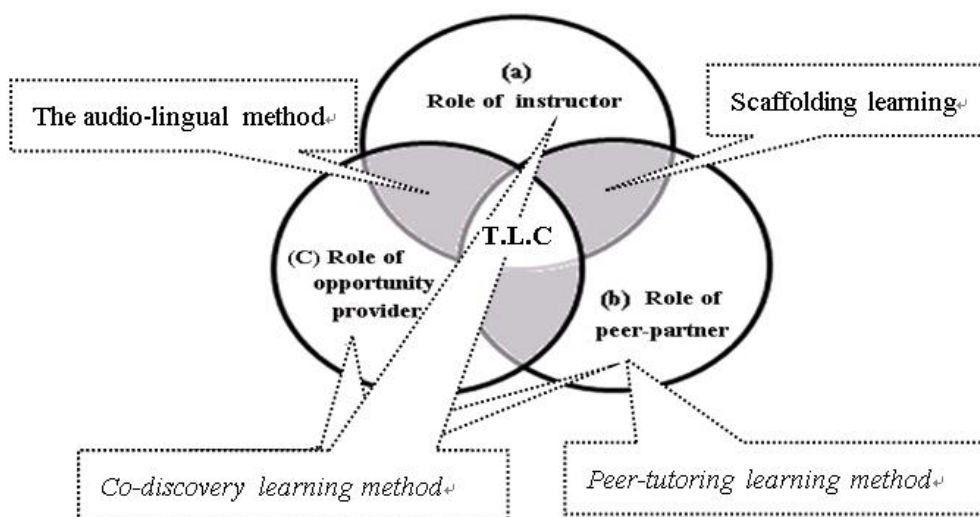


Figure 7. Tangible learning companions and the two learning methods

Speech recognition enhances language learning and teaching

In this study, the speech recognition technology has been integrated into the learning devices successfully. For a long time, technology enhanced language learning has focused more on language reading and writing but few on speaking skills relatively because of the limitation of techniques (Liu et al., 2002). The technique of utterance scoring and immediately interactive conversation with computers is a breakthrough in the field of technology-enhanced language learning. With the aid of the speech-recognition-based learning companions, learners won't feel uncomfortable to speak English in front of instructors. English teachers' load of taking care of each student in the big classroom could be released. The advantage of speech recognition technology brings the flexible opportunities both for teachers and students, so that the language learning and teaching will not be limited in English classroom.

Conclusions

This research extended the concept of learning companions from a virtual world to the real environment. The research teams jointly implemented the tangible learning companions for enhancing English conversation in the primary schools is the pioneering study in Taiwan to date. Results of this study indicate that the tangible learning companions had positive effects on learners' learning motivation, confidence and engagement. Learners viewed the English learning companions as interesting toys, robots, peer-partners or patient instructors for learning English and they felt more comfortable speaking English with less fear on making mistakes. For beginners, this is an exciting and important step to take when the tangible learning companions play the scaffolding role in helping the students learning a foreign language. It is important that the psychological learning barrier, caused by the language ego, could be reduced by using the tangible learning companions so that they could actively engage in learning English. Overall, the English instructor and students agreed that uses of the tangible learning companions effectively improve the class atmosphere, learning interest, and attitude of the learners in English learning.

We can conclude from the current study that uses of the tangible companions in the English-learning setting with the English beginners provide learners with more opportunities of practicing English conversation and motivate them to speak English more freely and comfortably. Meanwhile, it would help reduce English teachers' burden in the given instructional conditions of very limited English class time and very few sessions per week. It is our hope that the affordances of this kind of learning devices could be used to encourage learners to speak English more comfortably and enjoy the process of interactive English learning. In addition, it can enhance learners' English speaking proficiency.

At the current stage, due to the small size of the learning companions along its embedded speech chips, the rate of accuracy is around 92.5% and its capacity of the speech chip allows up to 30 sentences in the system that, to date, is enough for the beginning learners. However, to meet the demands of more complex English learning settings and to achieve higher rates of accuracy as up to 100% eventually, we are tackling the limitation by applying the cloud computing technology. In the future, the research teams will continue to jointly develop more powerful learning companions to address more instructional needs and research issues as well. In addition, we will explore the learning effectiveness between the tangible learning companions and computer-based avatars in language learning settings. Moreover, we attempt to combine the tangible learning companions with online learning. We anticipate exploring this series of tangible learning companions and devices in enhancing language learning and more research findings will be shared.

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