A Novel Approach of Learning English with Robot for Elementary School Students

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Abstract. Early school years are an important period to lay out the foundation for learning a second language. In addition to mastering basic language skills, keeping the learning process fun; promoting a life-long learning habit must be emphasized. This study explored the integration of books, computers and robots to create a novel English learning environment. Books are the most popular and familiar learning media. However if we can design a special mechanism linking books with digital learning material and robots, students will be able to obtain supplementary learning content. This mechanism includes meaningful action performed by the robot to enhance learning outcome. A new learning system has been designed and developed. The learning system was tested while data collected from field observation and interviews were analyzed. The results suggest that this system was fertilized students' learning experience and enhance students' concentration, learning interest and motivation.

Keywords: Book, Digital learning material, Robot, Learning English.

1 Introduction

Crystal [1] mentioned that about a quarter of the world's population is already fluent or competent in English. Being able to communicate in English will be helpful in adapting oneself to the international society. Many non-English-speaking countries regarded English as an important foreign language and are committed to improving students' fluency in English [2].

Developmental social psychology [3] suggested that human development consists of eight stages, with each stage corresponding developmental outcomes and strengths. Erikson suggested that failure in one stage will cumulate and hinder the development of the stage that follows. Positive experiences in achieving the stage outcome serves as a foundation for later development, whereas negative experiences resulted from encountering challenges in a particular stage will undermine subsequent development. It is important to motivate young students to learn English while keeping the learning process joyful and enjoyable to gain positive language learning experiences.

We considered integrating books, computers and robots to create an English learning environment. While many emerging technologies have been applied to support English learning, Bannert et al. [4] suggested that the combination use of traditional books and technology-enhanced learning outperformed the mere use of

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e-learning materials. Books are the most popular learning medium thus integrating digital learning materials and robot into conventional usage of books not only reduces the distraction resulted from context switching in the book, but also enriches the representation of plain text with multimedia and motions. For example, Neri et al. [5] suggested that applying computer technology to provide students with correct pronunciation of vocabulary benefits students learning a foreign language. In addition, the robot provides a more concrete way of explaining abstract concepts hence fostering deeper understanding in learning [6]. To be able to take full advantage of different learning resources, a well-designed integration of books, digital learning materials, and robot is needed.

This study aimed to explore the integration of books, computers, and the robots from three perspectives: (1) instructional design, the way to design and develop an integrated approach to effective English learning; (2) system evaluation, if this integrated system can be useful in motivating student to learn English language; and (3) usability, how much students favour this system in terms of their acceptance and willingness to use this system in the future. We first address the notion of system design and the explanation of learning-support functions, followed by the methodology, results and findings. We then discussed some relevant issues in this study and provide suggestions for future research.

2 The Design of the Learning System

Nowadays people learn from reading books and turn to computers or other resources for additional information when encountering difficulties. This conventional way of learning has two potential problems. First, learning a foreign language solely from books has limitations as mentioned earlier. Print text does not provide multimodal information such as audio or video to learners nor can it interact with the learner to provide feedback which is important for learning a foreign language. Second, learning with books and the computer as two separate resources is less efficient and one can easily get distracted when switching back and forth between two different contexts. For example, when one encounters some difficult words in reading, he or she would go online to look up the words in an online dictionary. When looking up the words online, the student may turn to the news or emails in addition to learning new words. Switching learning contexts as such could potentially distract the learner from what he or she was learning, and defeat the learning process.

Second, the computer-assisted learning systems lack enough interactivity that motivates students to actively participate in the learning activities.

Third, as Liu [7] noticed, learners often have insufficient practice in spoken English after class, which results in the situation were students are not confident in speaking in English. Part of the reason is that students are not motivated to use English language after class. A computer-assisted learning system, thus, should be able to engage students in practicing their oral English in the real context simulated by the computer system.

Considering all of the above issues, a game-based learning environment can be the best option in building a learning system to motivate students to actively participate in learning activities [8] and to enhance their engagement in learning [9]. We used both

verbal and pictorial representations in the learning material to benefit students' understanding [10]. The robot, Bioloid, was employed in the present study because of its low cost and high versatility [11]. We used this system to create a context in which the learner is allowed to interact with the system and receive feedback from the system. This two-way interaction is made possible in the proposed learning-support system.

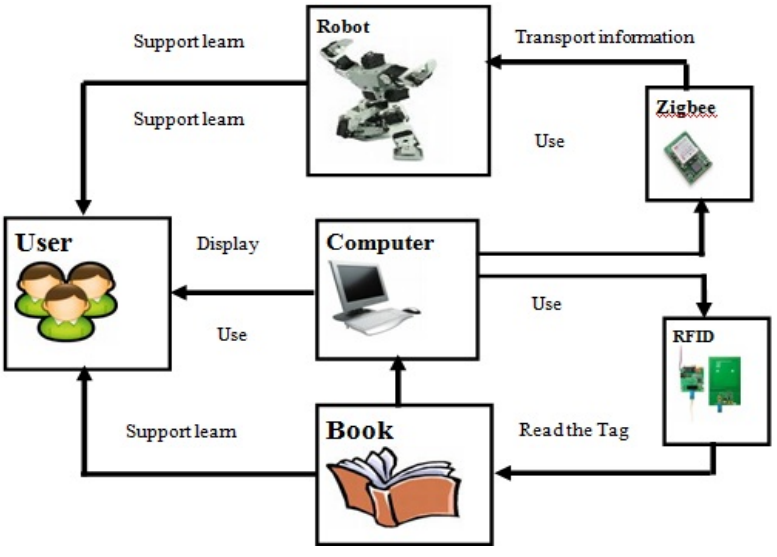

Fig. 1. The architecture of the learning system

We used radio frequency identification (RFID) system to connect the book and computer, and Zigbee technology to connect wirelessly the computer and robot. Among recent development of wireless communication technologyies, RFID features low cost, intuitive operation, and contextual adaptability which attracts much attention. It has been widely used in our daily life, as well as educational settings [12]. Similarly, the Zigbee technology, which has been adopted as one of the communication standards, features low power consumption, low cost, high reliability, and multi-node support, and was used in this system to provide stable wireless signal transmission between the computer and robot. The Zigbee technology frees the robot from the cable connection that could constrain the robot's movements and motions.

In the learning practice, as shown in Figure 1, one can learn English with the orchestration of the book, computer, and robot. When a learner has difficulties in understanding certain vocabulary (or sentence), he or she uses the RFID reader to point to the word (or sentence). The RFID reader detects RFID tags embedded in the book and transmits the object information to the computer. The computer then fetches the stored multimedia object associated with the RFID tag and displays the lexical information on the screen together with the audio and/or video output. Meanwhile, the robot receives the request sent out by the computer via the Zigbee signal and performs the corresponding motion(s) to help the learner better understand the meaning of the

word (or sentence). All these processes are initiated by the learner during the learning activity.

3 System Implementation

The learning-support system consists of six types of learning activities, including vocabulary, single sentence read-along, full article read-along, conversation, singing and dancing, and cloze test. The features of each learning activity are described below.

3.1 Vocabulary Learning

In this system, students used an RFID reader to point to pictorial icons in the textbook. RFID tags were embedded in the pictures. When the RFID reader detects the touch action of the icon, and it sends the identity of that learning object to the computer. The computer fetches the corresponding multimedia information from the database and presents it to the learner. For instance, if the RFID reader approaches to the specific icon, a video clip will be displayed on the computer. The computer will utter the word. In this way, learning vocabulary does not require learners to use the keyboard, hence no keyboarding is necessary.

3.2 Single Sentence Read-Along

When a learner does not understand a particular sentence, he or she can select a single sentence to read along as many times as he or she needed. The computer will play the sentence and the robot will perform the corresponding motion. This makes learning reading sentences more enjoyable and enriches learner's learning experience.

3.3 Full Article Read-Along

Being familiar with each single sentence, the learner can proceed to read the whole article along with the computer. The icon  shown in Figure 2 indicates the function of reading the whole article with the computer.

3.4 Conversation

To help learners obtain a more realistic experience in spoken English, this part of the learning activity provides the learner with an interactive way of practicing conversation. In a fabricated context, the learner is allowed to play one role in the conversation, whereas the robot plays the other. Through the microphone, the learner can "really" talk to the robot, and the robot will act and move according to the content of the conversation. This feature makes the conversation as realistic as it happens in daily life. The example shown in Figure 2 illustrates how the conversation activity can take place. First, the learner chooses a role for the robot. In this case, the learner wants the robot to play Sam, he or she uses the RFID reader to sense the icon 

to be Sam. Likewise, if the learner wants the robot to play the role of Peter, he or she can use the RFID reader to sense 

. After choosing the role, the conversation begins.

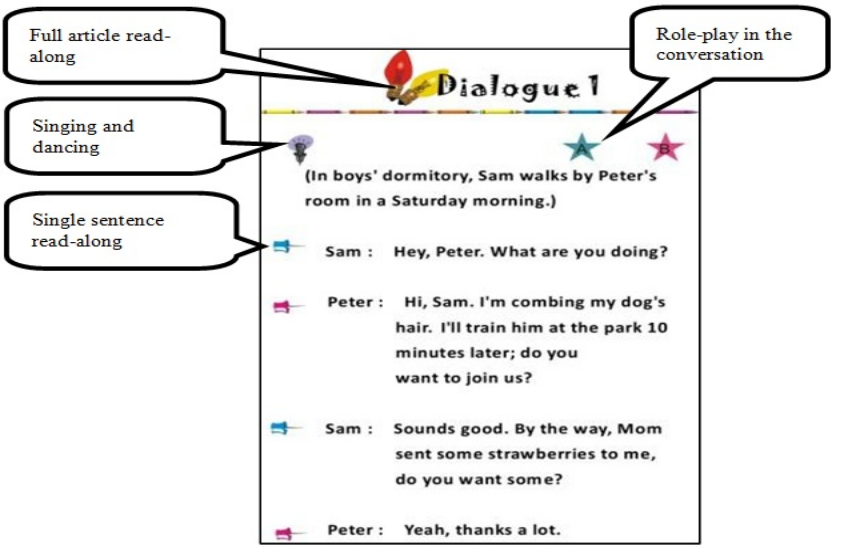

Fig. 2. An example page of the conversation activity

3.5 Singing and Dancing

To learning vocabulary, sentence, and the conversation, the proposed system also provides the function of singing and dancing performed by the robot. The system will play the song once. As the computer is playing the song, the robot will dance along the song, and asks the learner to sing (or dance) along with the robot.

3.6 Cloze Test

We provided learners an alternative to learn English by filling in blanks. We selected a bunch of verbs and attached RFID tags to them. In a story, where the verbs are missing, the learner is allowed to fill in the blanks with proper verbs by sensing the RFID reader to them. There is no correct answer for the story, so the learners can make their own story by varying verbs in the sentences. The robot will perform the motion corresponding to the selected verb. After completing the whole story, the robot can perform a series of motions according to the story.

4 System Evaluation

We applied qualitative research methods with five fifth-graders (three boys and two girls) participated in this study. These students were using a textbook (with RFID tags embedded in it), a laptop along with an RFID reader, and the robot. The procedure of the experiment is described in Table 1.

Table 1. Procedures of the experimental English course

Steps		Purpose and observation
1	1.1.	Introduce students to the system and its features
	1.2.	Observe how the student reacts to the system (the robot).
2	2.1.	Instruct students on how to use the system to learn English
	2.2.	Observe how the student learns English in terms of the joyfulness, & active participation.
3	3.1.	Interview with students about their learning experience & obtain feedback
4	4.1.	Interview with the teacher and consult him/her on how to help students learn better with the system, and the comparison of the system with others similar systems, and possible improvement of the ystem

5 Results and Discussion

5.1 Video Recordings

The proposed system is easy to use and motivates student to English learning. At the beginning of the experimental course, all five students were able to operate this system shortly after the researcher's demonstration and proceeded to the learning activities, given that they did not have prior experience of using the system. During the whole learning process, all five students concentrated on the learning materials shown in the screen and the robot. They took turns to use the system, and were fully engaged, actively participated in the learning activity. It is evident that students were highly motivated and having fun while learning in the process.

5.2 Interviews

Students preferred learning in an interactive environment. Four out of the five students enjoyed the activities of conversation, singing and dancing (dancing with the robot). It is apparent that students preferred learning English in a more interactive fashion.

Students preferred learning vocabularies with pictorial representations. Three out of five students expressed that "the new way of memorizing vocabularies is better than the traditional learning system because the new system provides a corresponding picture and word along with the animation, which brings forth a deeper understanding."

Interacting with the robot is fun. Four of the five students mentioned that they "enjoyed having conversation with the robot because the robot performed the motions." Interacting with the robot helps students obtain the first-person experience in conversation, which enriches the interactions between the learner and computer.

Practicing conversation with the robot helps students become more confident in speaking English. Three students expressed that "a long-term practice of conversation with the robot will help me feel more confident in speaking English." Therefore, we believed that the use of robot encourages students who are reluctant to speak English

to have conversation with the robot, and through this process students build up confidents in their spoken English and willing to communicate in English.

Students have a positive toward using the system to learn English. Students gave positive feedback to the system. Four students mentioned that "this system facilitates the practice of vocabulary, pronunciation, and conversation after class because we can learn the word and its pronunciation without typing the word into the computer or looking it up in the dictionary."

Multimedia effects could be attractive but may not last long. The teacher mentioned that "learning with multimedia could be fascinating to a large number of students at the beginning, but the learning effect will fade away if there are no continuous updates to the material."

The cost could be an issue. The principal mentioned that "the cost of the learning system will influence parents' decision to adopt the system in learning English." Considering the cost, therefore, the scalability and compatibility of the learning system needs to be taken into account in designing and developing the system. In our case, the content materials should be updatable, changeable, and replaceable, such that the computer, robot, and RFID facilities can be re-applied to other disciplines to keep the learning cost reasonable.

6 Conclusions, Suggestions, and Future Study

This study attempted to integrate the books, computer and robot to develop an English learning system, and to understand if the system is useful in motivating students to learn English in terms of the engagement, joyfulness, and activeness. We designed six types of learning activities in the system. In each learning activity, the computer provides pictorial representations and animations along with audio effects to students. Students interacted with the computer by an RFID reader to read the function icons or word cards (embedded with RFID tags) which lowers the overhead in the interaction with the computer system. The use of robot benefits students in obtaining a first-person learning experience in conversation, singing and dancing with the robot. Students felt comfortable in practicing oral conversation with the robot.

The field observation and interviews suggested that this system can indeed motivate elementary school students to learn English and engage them in learning activities. The students were all positive towards the system and enjoyed learning with the system. The design of the system provides students a context that is highly interactive which surpasses that of conventional computer-assisted learning systems.

Future research of this system can be focused on several aspects. First, we will develop an authoring tool which allows learners to design or compose the animation and robot's motions to help deepen learners' understanding of the learning content. Second, we will develop a composing tool which allows students to upload their favourite English songs and to have the robot dance along with the new song. We expected that the speed of narration can be adjusted according to the user's needs. Third, the current system was developed on platform of a laptop computer. In the future, the system should be scalable and transplantable to mobile devices such as PDA or smart phone to make it portable and movable. Also, digital learning materials

should be unloadable to the Internet (e.g., the cloud servers), so that the learners can access those materials anytime, anywhere.

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