A Basic Study on a Task-based Style Foreign Language Learning Environment Using RFID and a 3DCG Character

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Abstract
This paper presents a method of integrating RFID tags and a 3DCG character into a foreign language learning environment, mainly focusing on the following two objectives: (1)The application of RFID tags to the use of cards or realia as learning materials in task based-style foreign language activities; (2)The use of template programs to support TVML script production for 3DCG contents. From the results of the experiment, we found that the prototype system was easy to use and the system with RFID tags shows the possibility of achieving task-based style activities. Regarding script production, most participants had no problem editing the vocabulary and expressions in the text files to increase the variation of the TVML scripts. This suggests that the prototype system is not complicated for non-professional system users, although it might be much simpler for advanced computer users to place all the data within a single CSV file for editing according to their comments. Thus, we found that the support for script production should depend on users' computer skill level. Regarding the introduction of a 3DCG character, the results suggest that a 3DCG animated character is a better conversation partner than a 2D still character. The results also suggest that practicing with a 3DCG character could help to reduce nervousness and shyness in learners, and may help them to become familiar with real conversation. However, regarding this point, there may be individual differences in opinion depending on age, gender and personality according to some comments of the participants.

Keywords: RFID, 3DCG character, language learning, support for script production, TVML, T2V

Introduction

According to the general policies regarding curriculum formulation introduced by MEXT (Ministry of Education, Culture, Sports, Science and Technology-Japan) (2008a, 2008b, 2009), it is important to promote foreign language communication skills. In particular, familiarizing novice learners with native pronunciation and basic target language expressions is a priority issue. Subsequent to this policy, an increasing number of elementary schools in Japan begin the curriculum by focusing on listening and speaking activities; however, many elementary school teachers are relatively unfamiliar with teaching foreign languages. Statistics from MEXT (2014) and the Hyogo Prefectural Institute for Educational Research and In-Service Training (2009) demonstrate that not a few teachers are anxious regarding how to teach English in their foreign language classes, and have, in fact, demonstrated an interest in using IT and Multimedia in their classroom activities. The general curriculum policies formulated by MEXT (2006) also mention the importance of integrating technology into classroom activities.

Constructing an environment for foreign language learning could be one of the countermeasures to support listening and speaking activities. In particular, if we apply RFID (radio frequency identification) technology, it is possible to embed a learning environment within the real world.

On the learners' side, when they use foreign languages in face-to-face communication, they may feel inhibited, shy, or nervous (Horwitz et al., 1986; Matsumiya, 2010). By using a CG character or avatar in an online virtual world such as Second Life, they feel a little safer to talk with the character, as reported by Deutschmann et al. (2009) and Wang et al. (2009).

However, it is not always easy for language teachers to write programs or scripts by themselves when they customize CG contents and combine them with realia. Support for script production is necessary for such non-professional users.

In this study, we present a method of integrating RFID tags and a 3DCG character into a foreign language learning environment, mainly focusing on the following two objectives:

(1) The application of RFID tags to the use of cards or realia as learning materials in order to implement task based-style foreign language activities;
(2) The use of template programs to support TVML script production for 3DCG contents.

With regard to objective (1), it is monotonous simply to demonstrate model conversations or to study pattern practices of set phrases and key sentences in foreign language activities. A variety of task-based style activities using cards or realia enables learners to learn their target languages naturally. We are developing a way of applying RFID tags to a foreign language learning system based on previous studies (Kashiwagi et al., 2006; Kashiwagi et al., 2009) as discussed below.

RFID is a method of remotely storing and retrieving data using devices called RFID tags. An RFID tag is a small object, such as a plastic card or sticker, that can be attached to or incorporated into a product. RFID tags have an antenna to receive and respond to radio-frequency queries from an RFID transceiver (an RFID tag reader) (Akiyama et al., 2004). This has the advantage of integrating realia into the educational environment.

In the previous studies mentioned (Kashiwagi et al., 2006; Kashiwagi et al., 2009), a prototype system using RFID tags was developed to support activities based on the concept of the Total Physical Response (TPR) method. In the TPR method, learners respond to commands in foreign languages using physical responses, which enables them to understand the target language directly without translating the commands into their own language.

In this paper, we also use realia as learning materials by attaching RFID tags to them so that learners can interact with the system via these objects. Learners are required to respond to the commands from a 3DCG character of the system such as "I want an apple. Please pass me the apple," and select the appropriate tagged card or object. The 3DCG character then reacts to the learners depending on their answers. In this way, learners can experience foreign language activities in a simulative manner. Interaction between a learner and the system's 3DCG character realizes task-based style activities that differ entirely from repetitive model conversation practice. We anticipate that learners will gradually acquire words and expressions via such experience-based activities.

With regard to objective (2), the introduction of the 3DCG character is considered to help learners to become familiar with speaking foreign languages in face-to-face communication. In order to support script production for 3DCG content, text data files and template programs, including model dialogue patterns for the activities, are prepared in the system. Users only have to edit the target words and phrases in the data file and the data are then sent to the template program to easily produce 3DCG content.

To produce 3DCG content in the system, we use TVML (TV Program Making Language, TVML Home Page) and the T2V Player (T2V Home Page). TVML, as proposed by NHK (Japan Broadcasting Corporation), is a text-based language that produces TV-program-like 3DCG animation (Hayashi, 1996, 1999). This language enables users to create 3DCG animation on a PC using a text editor. The T2V technology (Hayashi et al., 2014) is built with TVML. The T2V Player is a software that can recognize TVML script and produces 3DCG animation with voice synthesis.

In the next section, we describe the prototype system. The experiment and the results and discussion are described in the following sections. Finally, we present our conclusions and recommendations for further studies.

Prototype System

In this section, we present a prototype system in which RFID tags and a 3DCG character are integrated.

System Overview and Flow of Instructions

Figure 1 and Figure 2 illustrate the prototype system developed in this study. This system consists of a PC, RFID tags, a tag reader, and a projector for displaying 3DCG content. The system was implemented using HSP (Hot Soup Processer) and Java. As shown in Figure 1, the T2V Program Executor generates 3DCG content by sending a TVML script to the T2V Player in the following process:

(1) The system generates a command prompt and executes a Java program. This program works as a template.
(2) The Java program generates the dialogue sentence data, referring to the arguments received at the time of startup. The data of the arguments are prepared in the data files, as mentioned later in Figure 4.
(3) A WAV file is produced from the dialogue sentence data generated in (2), using text-to-speech software.
(4) The Java program produces the TVML script data based on the generated dialogue sentence data and the WAV file.
(5) The T2V Program Executor acquires the TVML script data and sends the data to the T2V Player.
(6) The T2V player receives the TVML script data and executes the script to produce the corresponding 3DCG contents.

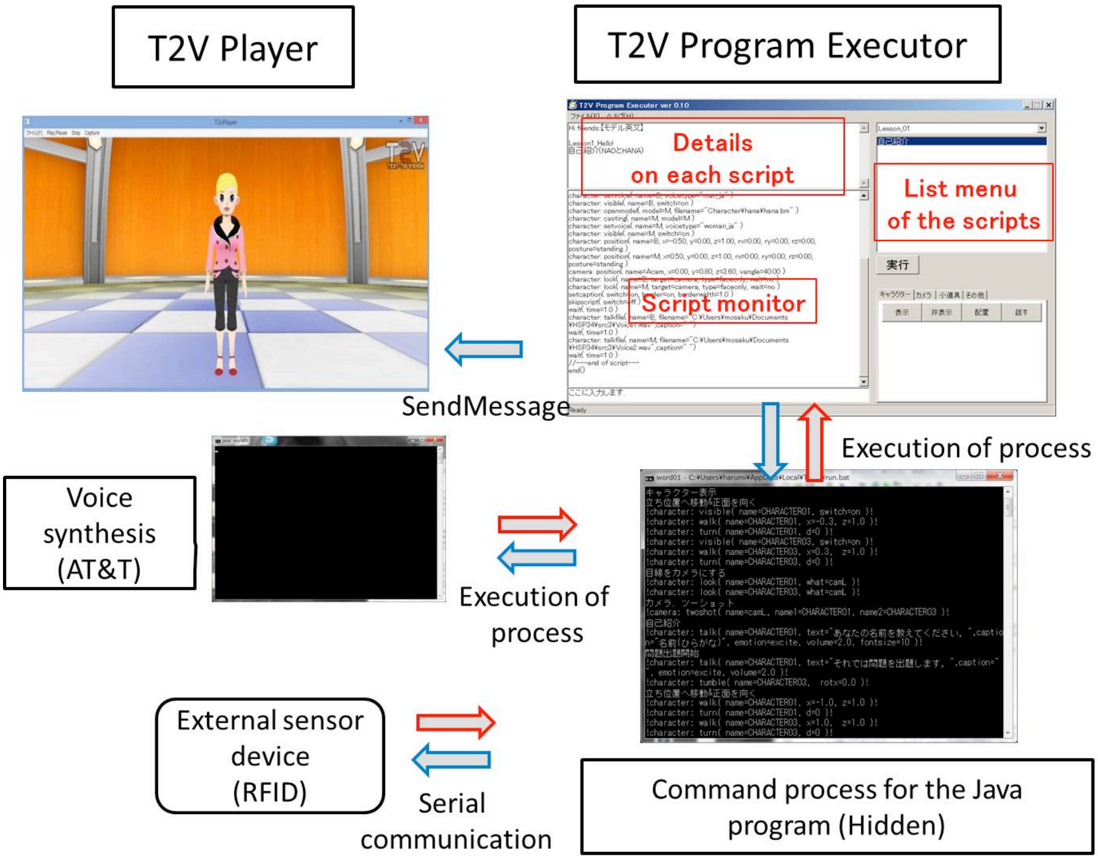


Figure 1: System overview

The interaction between a learner and the system is realized in cooperation with external sensor devices. In this study, RFID tags and a tag reader were introduced, which are described in the following section. The learner listens to the instruction given by a 3DCG character displayed on the screen, and answers the question by selecting the appropriate RFID tag. The Java program checks whether or not the selected RFID tag is correct. The system then generates the corresponding response sentence data and reads it out in a synthesized voice.

Next, the flow of instructions is described in Figure 2 with an example of 3DCG contents. When the teacher selects a script from the list menu of the PC screen, the system executes it in the process of (1) to (6) above. The projector displays a 3DCG character, and this character reads out a question in English: For example, "I want an apple. Please pass me the apple." When the learner answers the question by selecting the appropriate RFID tag and scans it by saying "Here you are," the system checks his/her answer. If the learner has given the correct answer by selecting an RFID tagged apple card, the system says, "Thank you." If the learner has selected the RFID tagged banana card, however, the system detects the error and reads out an error message pointing out what he/she has actually selected: "Thank you. But I am afraid it's not what I want. That is the banana. Please pass me the apple." In this way, learners can experience foreign language activities in a simulative manner.

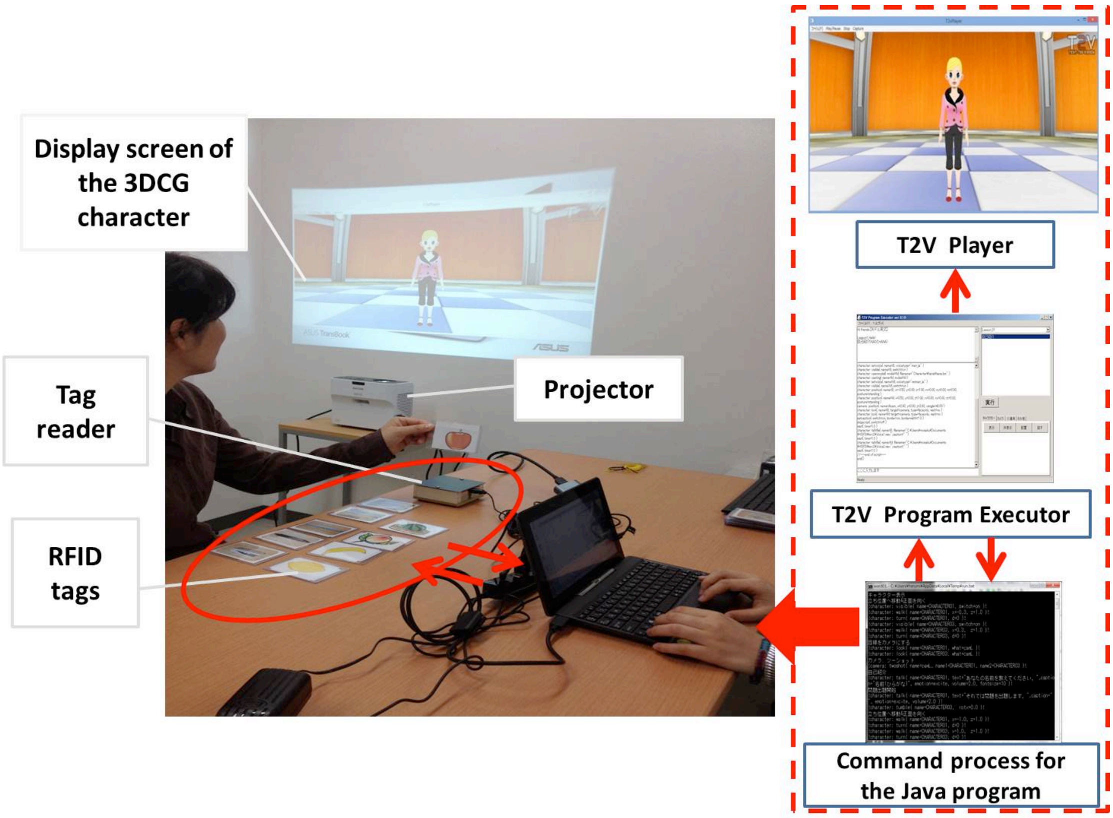


Figure 2: Example use of the prototype system

Introduction of RFID Tags as an External Sensor Device

The Java program, in cooperation with the external sensor device RFID, is employed to realize the interaction between a learner and the system (Figure 2). All the data related to RFID tags, including individual serial numbers and corresponding word data (i.e., apple, banana, etc.), are incorporated in a CSV file as shown in Figure 3, and the Java program acquires the data in that file at the time of program execution. When a learner scans an RFID tag, the data acquired are sent to the Java program in a serial communication. The Java program receives the tag data and checks whether or not the selected RFID tag is correct. The system then generates corresponding response sentence data and reads it out in a synthesized voice.

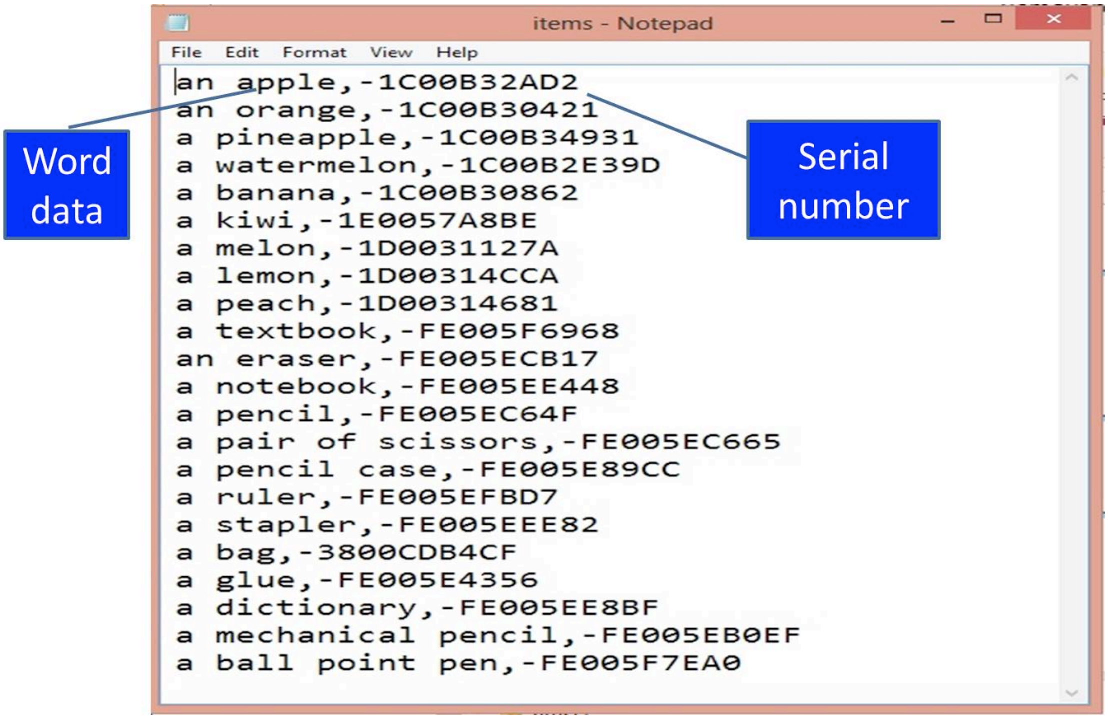


Figure 3: Example RFID tag information in a CSV file

This realizes the activity with RFID tagged realia as learning materials. Based on the RFID tag information, we will be able to further develop the prototype system to achieve various task-based style activities.

TVML Script Production Using Template Programs

In order to support TVML script production for 3DCG contents, template programs, including model dialogue sentence patterns for the activities, are prepared in the system. The data of the arguments are also prepared in the text data files as shown in Figure 4. When we edit the data of the arguments in the data file, they are sent to the Java template program at the time of execution. Based on this method, we can increase the variations of the same pattern of the TVML scripts and easily produce 3DCG contents.

An example TVML script production is described using Figure 4. In the example data file in Figure 4, “RFID_Sample03” represents the name of the Java Class file. “COM3” represents the RFID communication port number. “items.csv” represents the name of the RFID tag related information file. “2” represents the number of the loop time when an incorrect response occurs. “apple” represents the word data for the correct answer. Words and phrases, such as “an apple” and “the apple,” represent the sentence data necessary to generate dialogue sentences in the TVML script. For a comma separated list, the Java template program acquires the data of the arguments.

For example, to generate the example dialogue sentences shown in Figure 4, the Java template program obtains sentence data such as “an apple” and “the apple,” and substitutes them into the words and phrases enclosed in parentheses [ ] of the sentence pattern in Figure 4. Furthermore, the data of the RFID tag that the learner selects as an answer are obtained from the CSV file (items.csv in this example). In the example of Figure 4, the data “banana” is obtained from the CSV file as the learner’s selected RFID tag, and is substituted in the dialogue pattern in Figure 4.

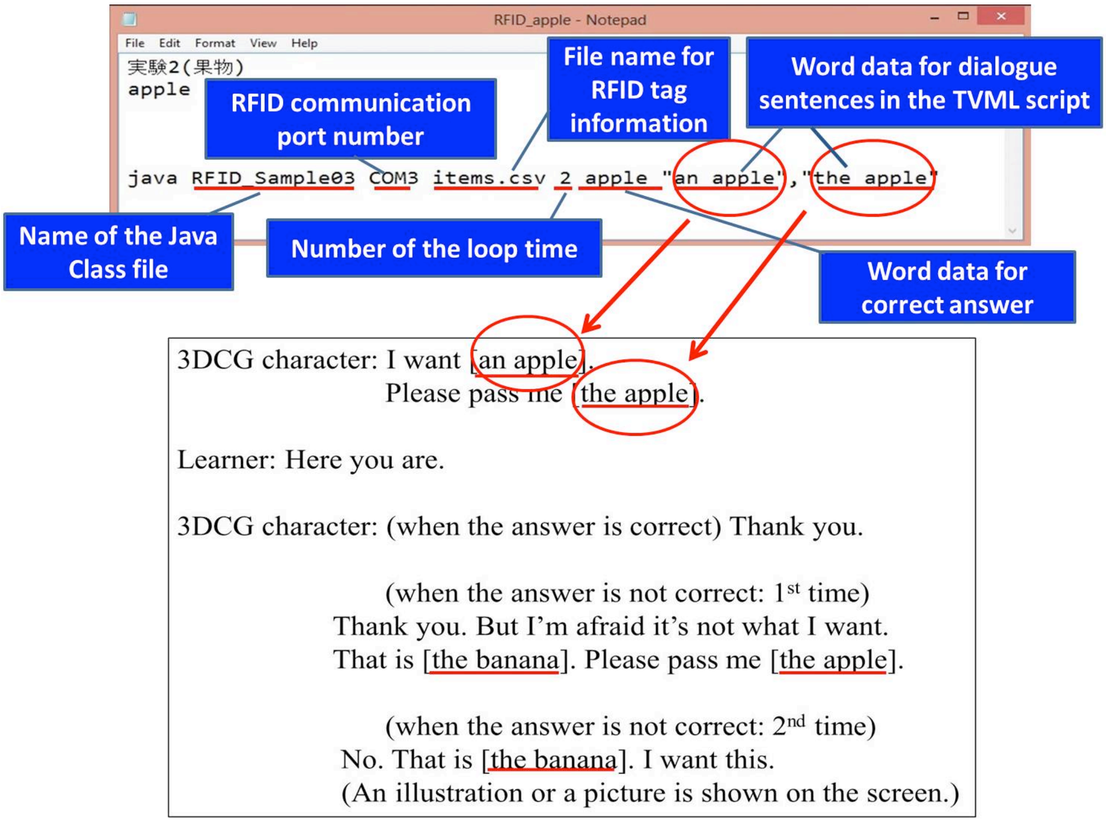


Figure 4: Example dialogue pattern

In this way, we can easily increase the variations of the same pattern of the TVML scripts for 3DCG contents merely by editing the words and phrases in the data files.

Experiment

Purpose

The purpose of this experiment was to investigate the following issues:

(1) The application of RFID tags to the use of cards or realia as learning materials in order to achieve task based-style foreign language activities;
(2) The use of template programs to support TVML script production for 3DCG contents.

Participants

Twenty-one participants were selected to evaluate the system. Their evaluations were assimilated with the help of a questionnaire. They comprised 12 graduate and postgraduate students, 3 foreign language educators at a university in Japan, and 6 parents whose children participated in the experiment as learners mentioned below. In addition to the above participants, 8 children (4 elementary school and 4 kindergarten) attempted to use the system as learners.

Procedures

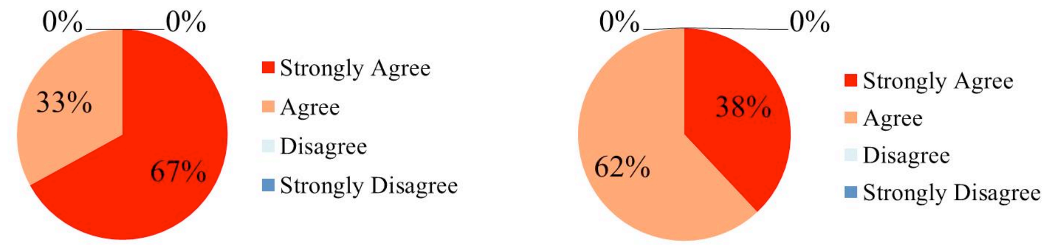
Firstly, each of the participants attempted to experience the system as a learner after receiving the necessary instructions on how to use it. Secondly, they attempted to use the system by selecting the script files for 3DCG contents in the role of teacher. Lastly, they produced variations on the TVML scripts by editing the words and phrases in a text data file. Subsequently, they were asked to complete a 10-item questionnaire and interview regarding the application of RFID tags to foreign language learning environments, and on the template programs used to support TVML script production for 3DCG contents. Regarding the children as participants, after they had attempted to use the system as learners, they were asked to comment on the activity using RFID tag cards.

Results and Discussion

Here, we discuss the introduction of RFID tags and a 3DCG character into the prototype system.

Introduction of RFID Tags to the Prototype System

Twenty-one participants were asked to select the statements that best described what they had observed from the options. Q1 and Q2 in Figure 5 are regarding the introduction of RFID tags into the system. In the pie chart, red represents 'Strongly Agree', light red represents 'Agree', light blue is for 'Disagree', and blue is for 'Strongly Disagree'. According to the results of Q1, all participants (67% strongly agreed and 33% agreed) showed agreement with the statement, "The system with RFID tags and a tag reader is easy to use." The results indicate that the RFID tags are easy to use both for teachers who are unfamiliar with IT as well as for learners. This suggests that the RFID applied system would be easy to introduce into language activities at elementary schools.



Q1. The system with RFID tags and a tag reader is easy to use.

Q2. The system with RFID tags is useful for learning activities.

Figure 5: Results of the questionnaire on the introduction of RFID tags into the system

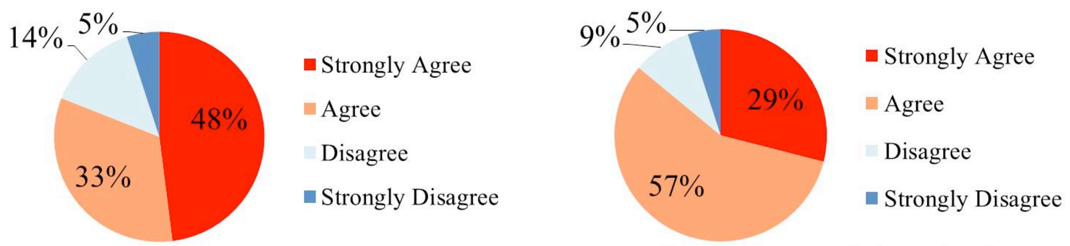
According to the result of Q2, all participants (38% strongly agreed and 62% agreed) showed agreement with the statement, "The system with RFID tags is useful for learning activities." Some participants also mentioned the following: "These activities with physical responses based on the TPR method might help elementary school children to concentrate on their activities. They seemed to enjoy playing games." Some of the participant children also commented that the RFID tags were easy to use and the activities were fun.

The result shows that the system using RFID tags had a positive impact on the participants. This demonstrates the possibility of implementing task-based style activities with RFID tags, which would broaden the variety of language activities. In this case, we used RFID technology; however, the introduction of other sensor devices, such as infrared sensors, motion sensing input devices like Kinect, and so on, into the system might achieve more complicated task-based style activities.

Script Production for 3DCG Contents and Introduction of a 3DCG Character

Support for TVML Script Production

Q3 and Q4 in Figure 6 are regarding the use of the system in the role of teacher. From the result of Q3, a total of 81% agreed (48% strongly agreed and 33% agreed) with the statement, "I could easily manage to choose the scripts for displaying a 3DCG character on the computer screen." Positive feedback was received regarding the system interface. Most participants found it easy to use the system.



Q3. I could easily manage to choose the scripts for displaying a 3DCG character on the computer screen.

Q4. I could easily manage to edit the words and phrases in the text data files and increase the variation of scripts by myself for my own activities.

Figure 6: Results of the questionnaire on the use of the system in the role of teacher

This system also enables teachers to increase the variations of TVML scripts solely by using template programs and editing the words and phrases in the text data files in which the data of the arguments are prepared. From the result of Q4, a total of 86% agreed (29% strongly agreed and 57% agreed) with the statement, "I could easily manage to edit the words and phrases in the text data files and increase the variation of scripts by myself for my own activities." Regarding the script production, most participants had no problem editing the vocabulary and expressions in the text files. It seemed that each text file contained an appropriate volume of data and it was easy for them to know where to edit. This suggests that the prototype system is not complicated for non-professional system users. However, 14% of participants (5% strongly disagreed and 9% disagreed) showed disagreement with the statement of Q4. They did mention that editing text files one by one to increase the variations could be confusing. These participants were advanced computer users. Thus, it might be much simpler to allow such users to place all the data within a single CSV file for editing. From these comments, we found that the support provided for script production should depend on users' computer skill level.

Introduction of a 3DCG Character

From Q5 to Q10 in Figure 7 are regarding the introduction of a 3DCG character. According to the result of Q5, a total of 95% agreed (52% strongly agreed and 43% agreed) with the statement, "I feel that an activity with a 3DCG animated character is better than one without such a character (voice only)." According to the result of Q6, a total of 95% agreed (67% strongly agreed and 28% agreed) with the statement, "I feel that a 3D animated character with some reactions such as nodding is better than a 2D still character as a conversation partner." The results above suggest that it is better to use a 3DCG animated character than a 2D still character as a conversation partner.

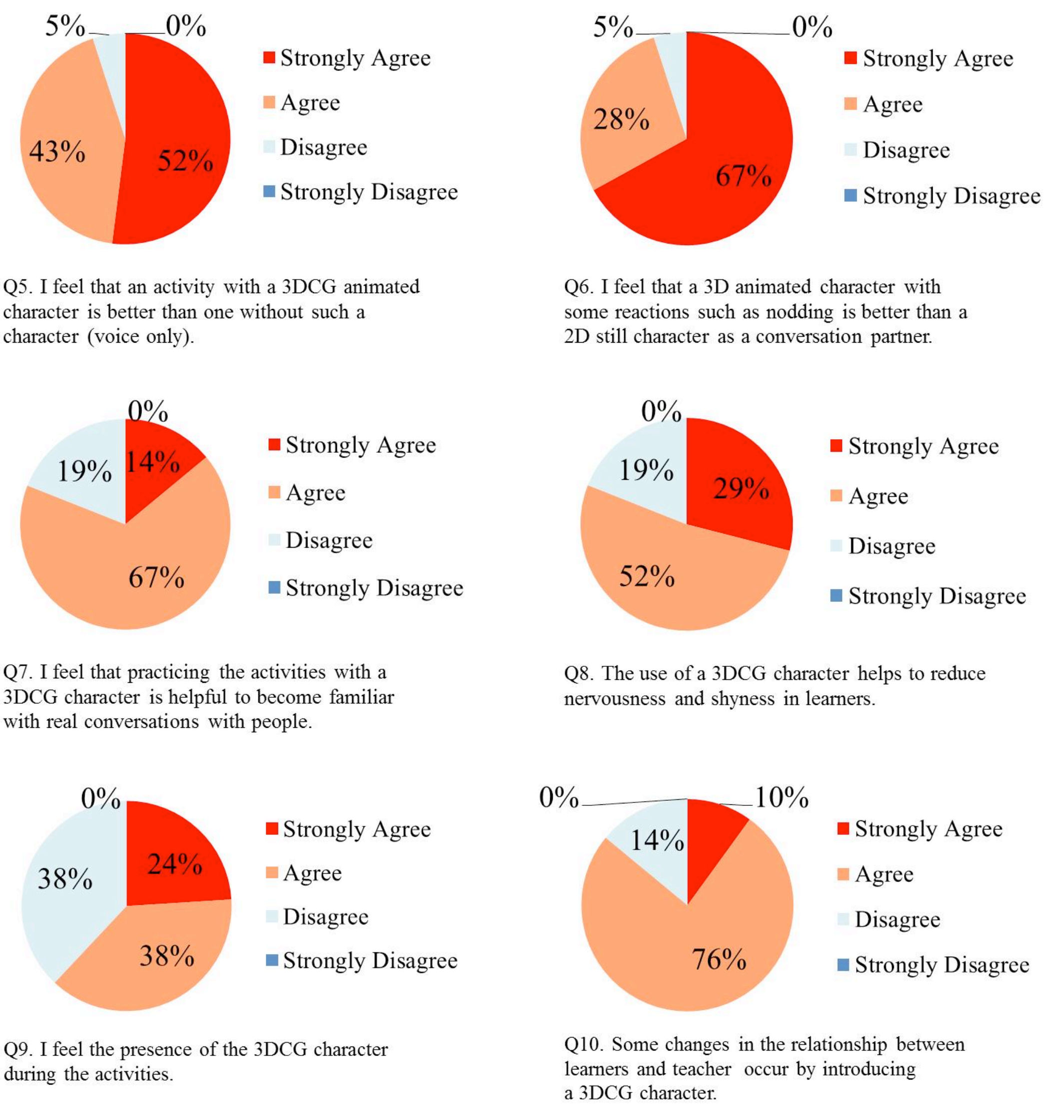


Figure 7: Results of the questionnaire on the introduction of a 3DCG character into the system

Furthermore, from the result of Q7, a total of 81% showed agreement (14% strongly agreed and 67% agreed) with the statement, "I feel that practicing the activities with a 3DCG character is helpful to become familiar with real conversations with people." From the result of Q8, a total of 81% showed agreement (29% strongly agreed and 52% agreed) with the statement, "The use of a 3DCG character helps to reduce nervousness and shyness in learners." The results above suggest that practicing with a 3DCG character could help learners to reduce their nervousness and shyness, and might help them to become familiar with real conversation. However, regarding this point there may be individual differences in opinion depending on age, gender and personality according to the comments of a few participants. Given the limitations of the data, we will continue to investigate further.

Regarding the result of Q9, in total, 62% agreed (24% strongly agreed and 38% agreed) with the statement, "I feel the presence of the 3DCG character during the activities." In the result of Q10, a total of 86% agreed (10% strongly agreed and 76% agreed) with the statement, "Some changes in relationship occur between learners and teacher by introducing a 3DCG character." In the experiment, we observed that a few of the child participants asked for the name of the 3DCG character. It seems that they regarded the character as a partner in the activities. Two-thirds of the participants also felt the presence of a 3DCG character. Thus, they might regard the character as a participant. The results above suggest that the presence of a 3DCG character might provide an opportunity to facilitate interaction among participants, and also between learners and teacher. Regarding this point, some participants mentioned, "It seems that the activities between learners and a 3DCG character generate interaction between learners and teacher, such as giving hints or pointing out learners' mistakes." A similar suggestion is found in Kashiwagi et al. (2016).

However, in this study, participants focused more on the RFID tags in the activities. Therefore, it is likely that they did not pay much attention to the 3DCG character. We need to investigate further by carrying out different types of activities in which learners can communicate directly with a 3DCG character so that we can observe whether or not they feel the existence of that character, and whether any changes occur in the relationship between learners and teacher.

In addition, regarding the possibility of using 3DCG characters other than human characters, the following comments were made: "Animal characters, such as a dog, a cat, and a rabbit are familiar in our daily lives. It could be interesting to introduce them as 3DCG characters."

Conclusion

In this study, we presented a method of integrating RFID tags and a 3DCG character into a foreign language learning environment, mainly focusing on the following two objectives: (1)In order to realize task-based style foreign language activities, RFID tags were used to integrate realia as learning materials into the system. (2)Template programs were considered in order to support TVML script production for 3DCG contents.

With regard to objective (1), cards or realia were used as learning materials by attaching RFID tags to them. Learners were required to respond to the commands of a 3DCG character such as "I want an apple. Please pass me the apple," and to select the appropriate tagged card or object. Thus, they experienced the foreign language activities in a simulative manner.

With regard to objective (2), the introduction of a 3DCG character was considered to help learners to become familiar with speaking foreign languages in face-to-face communication. In order to support script production for 3DCG contents, text data files and template programs, including model dialogue patterns for the activities, were prepared in the system. When users have only to edit the words and phrases in the data file, the data are sent to the template program and they can easily produce 3DCG contents.

In the experiment, 21 participants used the system as learners after receiving the necessary instructions on how to use it. Next, they attempted to use the system in the role of the teacher. They then produced variations on the TVML scripts by editing the words and phrases in a text file. In addition, 8 children attempted to use the system as learners. Subsequently, we conducted a 10-item questionnaire in which each question was designed to gather participants' responses on the introduction of RFID tags and a 3DCG character into the system as well as on the support provided for TVML script production.

From the results of the experiment, we found that the system with RFID tags was easy to use and had a positive impact on the participants. This suggests that the system has the potential to achieve task-based style activities with RFID tags, which would broaden the variety of language activities.

Regarding script production, most participants had no problem editing the vocabulary and expressions in the text file to increase the variation of the TVML scripts. It seemed that each text file contained an appropriate amount of data and it was easy for them to know where to edit. Thus, it is anticipated that teachers will easily be able to increase the 3DCG contents for their activities, although it might be much simpler for advanced computer users to place all the data within a single CSV file for editing according to their comments. We found that the support provided for script production should depend on users' computer skill level.

Regarding the introduction of a 3DCG character, the results suggest that it is better to use a 3DCG animated character than a 2D still character as a conversation partner. The results also suggest that practicing with a 3DCG character can help reduce the nervousness and shyness of learners, and might help them to become familiar with real conversation. However, regarding this point there may be individual differences in opinion depending on age, gender and personality according to the comments of a few participants. Given the limitations of the data, we will continue to investigate further. Additionally, we found that two-thirds of the participants felt the presence of a 3DCG character during the activities, and some of them felt that its presence could facilitate the interaction between learners and teacher. However, we need to investigate further by carrying out different types of activities in which learners can communicate directly with a 3DCG character.

As a continuous study, we need to investigate the following points by carrying out different types of activities in which learners can communicate directly with a 3DCG character: Whether or not the existence of a 3DCG character contributes to real conversation, and whether or not the introduction of a 3DCG character enhances the interaction between learners and teacher.

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