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Abstract

During speaking practice, it is very important for learners to receive immediate feedback from their teachers. However, it requires teachers to be with learners simultaneously to help them practicing. To eliminate this restriction, we focus interactive learning support systems adapting to individual learners. Although existing systems just recommend contents based on estimation of some measures such as knowledge level and emotion, they can not estimate their speaking levels in speaking practice including free speaking. In addition, sophisticated devices, which are not freely available, are used in some studies. Our distant goal of this study is to develop a system which can give learners flexible feedback in speaking practice without restricting time and place to practice. Such a system will enable teachers to reduce their costs and for learners to practice speaking as many times as they like. After sorting out existing learning systems based on two aspects to identify inadequacies of these systems and define some requirements for such a system, we develop a prototype that fits this missing part and meets other requirements, including no restricting time and place for practicing. After that, we show the result of a preliminary experiment using our prototype for 14 weeks on 14 international students participating in a Japanese language course. It confirms some positive feedback and improvements in our prototype from a questionnaire.

Keywords: Learning Support System, Web Application, Preliminary Experiment, Japanese Language Course, Questionnaire.

1 INTRODUCTION

In language learning, such as second language and foreign language, we need to train the four basic language skills for communication: listening, speaking, reading, and writing. During speaking practice, it is very important for language learners to receive immediate feedback from their teachers. However, it requires teachers to be with learners simultaneously to help them practicing. This restriction still exists in case of online learning, which is widespread in the wake of COVID-19. If we can eliminate the restriction, we will be able to practice speaking with some immediate feedback whenever we want. In this study, we focus interactive learning support systems adapting feedback to individual learners.

Although existing systems adapt different measures, such as knowledge level and learning style, their fundamental functions are basically the same [1], [2]. That is, they just provide contents based on estimation of learners' characteristics or state. Therefore, many of them can not be directly applied to speaking practice because they just recommend contents according to the estimated measures, and they can not estimate learner's speaking levels. In addition, sophisticated devices including EEG (Electroencephalograms) headset, are used to obtain information about learners' physiological response to estimate learner's dynamic state in some studies [3]. Such a device restricts time and place to practice.

Our distant goal of this study is to develop a system which can give learners flexible feedback in speaking practice without restricting time and place to practice. Such a system will enable teachers to reduce their costs and learners to practice speaking as many times as we like.

However, there are two challenges to this goal; (1) developing such a system that checks atypical answers, like free speaking, is more difficult than developing one that checks typical answers, and (2) only few studies estimate learners' state using various information such as their face, voice, etc., which are usually used by teachers. Besides these challenges, there is one general concern in the studies using general computer systems. If system's usability such as UI (User Interface) is poor, the results of experiments are considered to be influenced by inconvenience of the system. In this paper, we show the result of a preliminary experiment to check our system's usability and collect data for improvement.

The contribution of this paper is threefold. (1) The authors sorted out existing learning support systems based on two aspects, synchronous vs. asynchronous, and interactive vs. non-interactive, and found a missing part on the segmentation. (2) The authors developed a prototype that fits this missing part and meets other requirements, including no restricting time and place for practicing. (3) The authors conducted a preliminary experiment using our system for 14 weeks on 14 international students participating in a Japanese language course, and confirmed some positive feedback and improvements in our system from a questionnaire.

2 CLASSIFICATION OF LEARNING FORMS

One learning system basically supports some learning forms. Therefore, it is important to know learning forms supported by existing systems. In this section, we classify learning forms based on the two aspects. This classification enables us to find a missing part of existing learning support systems.

2.1 Classification learning forms based on two aspects

There exist many learning support systems and they support many learning forms. For example, LMS (Learning Management System) [4], [5] supports asynchronous learning, and audience response system [6], [7] supports interactive lectures. Introducing the following two aspects, we can sort out these miscellaneous forms into four types.

One aspect is “synchronous” vs. “asynchronous”, and shows limitation degree of learning environment. That is, synchronous forms require for users to learn at a specific time and place or with someone else. On the other hand, asynchronous forms have no limitations on the learning environment as mentioned above.

The other aspect is “interactive” vs. “non-interactive”, showing availability of feedback. That is, interactive forms can give users immediate feedback to users’ input, or collect information for teachers to give feedback to users. On the other hand, non-interactive forms basically provide no feedback.

2.1.1 Asynchronous Non-interactive Learning

It refers to mainly input-based individual learning using analog materials such as textbooks or lecture materials. There are no restrictions on time or place in this form. On the other hand, the subjects that learners can study depend on the materials at hand due to physical restrictions. An LMS which manages materials enables learners to view digital materials such as video, as many as they want.

2.1.2 Asynchronous Interactive Learning

It refers to mainly output-based learning using the analog materials with questions and answers. In this form, learners are required to process learning outputs, such as self-marking, recording mistakes, and confirming model answers to know their knowledge level or determine their next goal for learning. The systems with quiz functions, including an LMS, enable learners to reduce the cost of learning by performing these tasks automatically on behalf of the learner.

2.1.3 Synchronous Non-interactive Learning

It mainly refers to face-to-face learning, aiming to give explanations to learners by a teacher. This form has been a traditional lecture form, and has restrictions on place as well as time. The classes using such systems, including video conferencing systems, enable learners to take lectures at distant locations. Affected by COVID-19 lately, many universities in Japan started to use such systems and then students are able to take lectures anywhere.

2.1.4 Synchronous Interactive Learning

It mainly refers to face-to-face learning, practicing or making a presentation for teachers or co-learners. In this form, teachers or co-learners can immediately provide feedback and thus we can say this form is adapted to each learner. Therefore, this form is good for checking the learner’s characteristics and state at each time. If questions or quizzes using an audience response system [6], [7] or a game-based learning platform [8] are used, teachers can give feedback dynamically.

2.2 Changing form of interactive speaking practice

Traditional speaking practice has been done as synchronous interactive learning. Getting feedback on outputs such as presentation or speaking is a merit of interactive learning. The feedback such as indicators of learner's position and advice can help learners move on to the next step. However, synchronous learning has restrictions that teachers are required to be with learners at the same time and place. Time restriction still exists in case of online learning. Speaking practice is synchronous learning and in this form of learning the time restriction is not resolved even with online learning systems. However, asynchronous learning does not restrict the time or place of learning, by giving feedback from a system. In this study, we will consider an approach eliminating the restriction through changing the form of speaking practice from synchronous to asynchronous, by using a system which provides feedback on learner's speaking instead of the teachers.

3 RELATED WORK

In this section, we briefly review studies aimed at interactive learning between learners and systems, that is, studies on a system that can change the speaking practice from synchronous interactive learning to asynchronous interactive learning.

3.1 Learning systems with speech recognition

The main feature of interactive learning support systems, such as Adaptive Learning Systems, is to adapt learning contents and navigation to the learner's characteristics, such as knowledge level and learning style [1], [2]. With reference to these studies, immediate feedback on learner's speaking should be provided by the system instead of the teacher. However, few existing systems have that. If a system can estimate the speaking level using speech recognition, it could be a factor in dynamically changing the feedback to the learner.

Here, as such a system we focus on Automatic Speech Recognition-based Computer Assisted Language Learning systems [9], [10]. These systems evaluate the learner's speaking by using speech recognition. Furthermore, they can increase variation for practice, dynamically generating questions using sentence templates and providing some choices and options in the content of speech. However, these systems have the following restriction: correct answers are must be prepared in advance and the types of sentences for speaking practice are restricted.

In speaking practice, free speaking is also very important. It is difficult to prepare correct answers in advance since learners can speak freely in free speaking practice. A system with pattern recognition is supposed to handle also handle free speaking. Thanks to the recent improvement of speech recognition by computers, you might expect that we can use highly accurate automatic recognition by computers. However, highly accurate recognition of non-native learner's speaking is inherently difficult. Consequently, we focus on the learner's dynamically state such as emotion or level of concentration, instead of directly estimating the speaking levels in this study.

3.2 Learning systems estimating learner's dynamically state

In studies on learning support systems that estimate the learner's dynamically state, many attempts have been made to estimate their state using peripheral devices. Hu and Kuo [3] proposed a system which chooses teaching materials based on continuous brainwaves of students as they study. It is known that brainwaves are highly correlated with one's mental states, including the level of concentration, emotional state, and degree of relaxation, and thus they are used to monitor the mental status of students engaged in learning. Their results demonstrate the efficacy of using EEG signals in feedback systems that adjust instructional methods and/or materials using important features related to learning performance from the EEG signals. Their research attempts to directly sense information to estimate the learner's state by using devices that measure brainwaves. However, using sophisticated devices leads to the restriction of the learning environment. In order for learning support systems to provide asynchronous learning, we must avoid using sophisticated devices.

Lin *et al.* [11] developed Affective Tutoring System for Japanese language learning that provides feedback to eliminate students' learning anxiety, which reduce learning efficiency when learning a second language. In their system, lessons of different difficulty grades and positive emotional feedback are provided by using facial recognition and input provided by learners with regard to their emotional state. This system only uses the camera as a peripheral device. From the perspective of the

peripheral devices, this system can maintain the asynchronous learning form. However, many systems, including their system, using face recognition are native applications that need to be installed on the device. Native applications basically limit the type of devices because their behavior depends on the devices. On top of that, development costs are high to support all kinds of devices. Therefore, operating environment is one of the factors that must be taken into consideration in order to realize asynchronous learning.

4 PROPOSING A SYSTEM

In the previous section, we summarized studies about systems for interactive learning among systems and learners. These systems can change the style of speaking practice from synchronous one to asynchronous one. However, it is difficult to estimate the speaking levels for free speaking to recommend materials. Moreover, estimating learners' state using a dedicated environment or sophisticated devices makes asynchronous learning impractical. In this section, we discuss the requirements for the configuration and functions of a system to provide feedback based on the learner's input while maintaining asynchronous learning.

4.1 Overview

The system provides feedback to the learner's speaking and state when he speaks according to questions and themes displayed on the screen. The accumulated answers will be used to improve a model that performs estimating learner's state and optimize it for individuals.

The system must be available from both PCs and smartphones to retain the merits of asynchronous learning, which is not restricted by time or place. Consequently, the system is required to be developed as a browser-based web application that runs without installation. Therefore, inputs from devices are limited to audio from microphones and images and video from webcams, supported by most browsers. Developing a system as a web application means that it does not require a dedicated environment or sophisticated devices. For these reasons, the system consists of a server and a client (web browser). (See Fig. 1)

The server has two roles. The first role is a database that stores question data and user data including learners' answers. The second role is application that provides questions requested by learners and receive their answers. The client has roles that displays pages and receive learner's inputs such as answer and state.

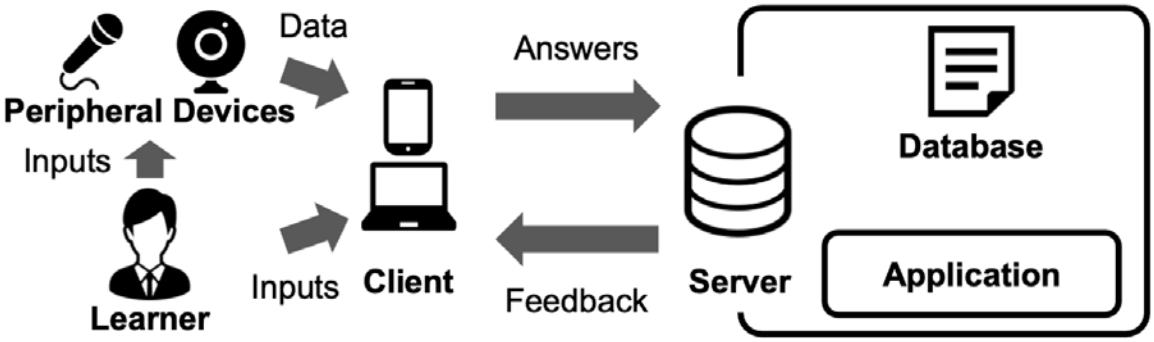

Figure 1. Outline of the system.

4.2 Functionality

4.2.1 Requirements for speaking practice

Speaking practice is required three processes: "providing question", "obtaining answers", and "providing feedback". "Providing question" is to display details of question or theme for practice; therefore, their texts in the database are applied to the Web pages' layout. "Obtaining answers" is to submit learner's answer data including the contents of speaking; therefore, the data are converted into a specific data format. "Providing feedback" is to display information such as text of sample answers or learner's state; therefore, answer data and accumulated data are used.

4.2.2 Requirements for displaying pages

For displaying pages, two requirements are defined. First, the pages must be a simple design for easy understanding of operation at a glance. It is considered that some learners are not good at using web applications and operating devices. Through designing the buttons and operations that are displayed as easy to understand as possible, we can make it possible for these learners to use the system. Second, the pages must be dynamically layout depending on learner's accessing device. Since there is a big difference between the screen sizes of PCs and smartphones, statistically creating pages only for one of them will lead to pages that are difficult to view for another device. For this reason, responsive web design is used; therefore, the page's layout is changed according to the screen size of the device.

5 PRELIMINARY EXPERIMENT

There is one general concern in the studies using a computer system. If system's usability such as UI are poor, the results of experiment are considered to be influenced by inconvenience of the system. In this section, we show the result of a preliminary experiment to check proposed system's usability and collect data for improvement.

5.1 Experimental setup

We chose "Active Japanese" as the target course for the experiment in this study. This course is one of the courses in Kyushu University for international students to learn Japanese for communication. The experiment was conducted by using the developed prototype. This course consists of "Active Japanese I" in the first semester and "Active Japanese II" in the second semester. We show the result of a preliminary experiment conducted in "Active Japanese I" from May to August.

5.1.1 Objectives

In order to develop to implement the proposed system to be used in our main experiment, three objectives were defined using the prototype. First, to stabilize our prototype. Next, to identify necessary features and factors and adjust them each time. And finally, to collect learner's opinions and learning data.

5.1.2 Environment

14 learners attending the course use our prototype to do after-class assignments. The authors explained to them how to use the prototype and distributed prototype instructions at the end of the class for first week. The assignments have deadlines. However, they have no limit to the time, place, or number of practices they can. Furthermore, the authors listen directly to learners' opinion during the question period at the end of each week's class.

5.1.3 Evaluation

Evaluation of our prototype is done by a questionnaire to learners at the end of the semester. It includes 13 items, asking for prototype's usability, features, good points, and improvements. The questionnaire contained 9 single-answer questions on a five-point scale and 4 open-ended questions. Its details are shown in the Table 1, where "PairBear" in the open-ended questions refers to the name of the prototype for learners.

5.2 The prototype of the proposed system

Our prototype is required to have some features, for example, it can be used to do after-class assignments, as well as the requirements listed in the previous section. In the following, we explain the details.

5.2.1 Practicing: Speech recognition & Vocabulary ranks

The practice page is the main page of our prototype, and was developed in accordance with the reference book "Dekiru Nihongo Shochukyu [12]" used in the course. (See Fig. 2(a)) The processing flow of the prototype when learners practice one question is (1) displaying problems, (2) receiving their answers, (3) sending their answers to the server, and (4) displaying feedback. The prototype displays

Table 1. Details of questionnaire, where "PairBear" refers to the name of the prototype for learners.

	Questions	Type
1-1	Do you immediately understand how to operate the system?	single-answer
1-2	Do you think the operation frequency required for what you want to do adequate?	
1-3	Do you get a quick response to your operations?	
1-4	Is arrangement of the buttons and elements easy to see?	
1-5	Is the design and color scheme of the text and buttons easy to see?	
1-6	Is the visual expression of the system fun to see?	
2-1	Do you check the RESULTS page?	
2-2	Do you use Vocabulary Rank & Vocabulary List as a reference or milestone for your practice?	
2-3	Is it easy to understand practice page after the update?	
3-1	How was the course using PairBear system for assignment?	open-ended
3-2	Please let me know the good points about PairBear system.	
3-3	Please let me know the points of improvement about PairBear system.	
3-4	If you have any other comments or opinions about PairBear system, please describe in below form.	

a question that has already been answered with "★". In addition, three "SUBMIT" buttons is implemented as an experimental feature to collect the learner's confidence at the time of answering. These buttons consist of "confident", "average", and "not confident", indicating the level of the confidence. By pressing any one of them, the prototype sends a value of learner's confidence with answer. In the following, we explain the details of (2) to realize speech recognition and of the experimental feature in (4).

Speech recognition: In our prototype, "Web Speech API [13]" is used to recognize learner's speaking. The API can do speech recognition and speech synthesis (text-to-speech). Hence, they are used for transcription of the learner's spoken sentences and the function of reading out the displayed questions or themes.

Vocabulary ranks: As an experimental feature for immediate feedback to learners, vocabulary ranks are introduced in our prototype. The rank was defined as an index calculated with difficulty levels of Japanese words used in the learners' speaking, referring to the six levels of vocabulary defined in "JEV (Japanese Education Vocabulary) [14]". Its calculation is done in the following three steps: First, the received text is separated to a sentence written with a space between words and converted to the original form of the word using MeCab [15], a POS tagger for Japanese. Next, a level is assigned to each word with JEV. And finally, the rank is derived by calculating the average of the vocabulary levels of the words.

5.2.2 Reflection on each class

"OPPA (One Page Portfolio Assessment) [16]" is used to write reflections of learners on this course. In OPPA, learners record outcomes and feedback on the course on a piece of sheet. Through recording them before, after, and after each class, teachers can evaluate learners, and learners can evaluate the course. We needed to implement this feature on a web page, instead of sheets. In our prototype, "Reflection Sheet" page is developed, and this page enables learners to reflect on all classes in one page as a "One (Web)Page Portfolio sheet". (See Fig. 2(b)) This page incorporates an animated accordion (collapsible content), so learners can show or hide entry fields of the reflection for a specific class or all classes. Learners can view the sheets according to their own objectives.

(a) Practice page for PCs and smartphones (b) “Reflection Sheet” page

Figure 2. Pages of our prototype.

6 RESULTS

6.1 Prototype adjustments

Several learners gave their opinions on what the system should be improved during the question period at the end of each class. Moreover, the authors confirmed necessary features for learners by checking their weekly progress. In this section, we see the features added and adjusted during the preliminary experiment.

6.1.1 Added features

When checking their weekly progress by the third week of classes, the authors confirmed that several learners had forgotten to practice only one or two questions even though they had practiced all the other questions. Consequently, the authors found that it is difficult for learners to notice whether questions are already done or not on our current prototype. To improve this situation, a new page called “RESULTS” has been added to the prototype. (See Fig. 3(a)) In this page, information of all questions, such as number of answers, latest answer, and answering date, are displayed. Further, each question has a button to go to that question, and thus learners can easily get to question they want to practice. Since the fourth week after implementing this feature, we have seen that learners tried to solve questions they had forgotten to do.

6.1.2 Adjusted features

Reflection sheet: One of the learners said, “When writing for reflection sheet, the contents I already input was erased after the page had got some errors.” This was happened because the learner took a long time to edit the page, causing no page transitions for a while, and the system judged it reached the pre-set automatic logout time. The input texts had not been submitted due to automatic logout. To solve this issue, sentences are automatically submitted every minute of editing.

Vocabulary rank: Originally, the ranks showed only the final average. However, the authors received opinions from a few learners that they had wanted to know how the rank is calculated. Therefore, “Vocabulary List” has added to show the vocabulary level for each word. (See Fig. 3(b))

(a) RESULTS page (b) Vocabulary Rank & List

Figure 3. Added feature & adjusted feature.

6.2 Results of the questionnaire

We conducted a questionnaire after the 14-week class in order to check the usability of the prototype, what good points and improvements are. Valid responses were received from all 14 learners in the course. The results of the questionnaire are shown in Table 2.

Firstly, we check the answers to 9 single-answer questions. First, for the three questions about the operation of the prototype, “Yes, I agree.” was the most common response. However, for “Q1-3. Do you get a quick response to your operations?”, there was one response of “No, I disagree”. Next, for the three questions about the UI of the prototype, the majority of learners answered “Yes, I strongly agree”. And finally, for the three questions about the adjustments to the prototype. As for the RESULTS page that was added, we found that many of the learners were willing to make use of it. As for the experimental indicator “Vocabulary Rank,” only three learners used it during practice although we improved the display of the details. Thus, for the improvement of the layout of the page displaying the questions, many respondents said that it was easier to see.

Secondly, we check the answers to 4 open-ended questions. When we asked the learners what they thought of the course using the prototype, we found positive responses such as “It was fun and unique.” and “It is easy to effective and efficient for quick speaking practice.” The learners’ answers to the good points of the prototype include “Easy to use, effective, fast response, and understandable command.” and “The assignment is clear. The goal is set every week. As the class is for speaking, the goal is fulfilled.” In all the open-ended questions as well as in the question of improvements, there were requests for improvement in speech recognition. There were various reasons for this, such as misrecognition, or being recognized different word with same sound. Lastly, in other non-compulsory questions asking for opinions, we received the support of the learners, e.g., “PairBear looks very good. Please improve the ranking system and the speech recognition more so that this program will be more perfect.”

Table 2. Results of the questionnaire.

Questions	***Rating scale***				
	1 (No, I strongly disagree.)	***2 (No, I disagree.)***	***3 (Neither agree nor disagree.)***	***4 (Yes, I agree.)***	***5 (Yes, I strongly agree.)***
1-1	0	0	1	8	5
1-2	0	0	1	10	3
1-3	0	1	1	7	5
1-4	0	0	0	6	8
1-5	0	0	3	3	8
1-6	0	0	3	5	6
2-1	0	0	0	3	11
2-2	1	7	3	2	1
2-3	0	2	1	7	4

7 DISCUSSION

7.1 About prototype adjustments

Our prototype was improved by adding some features based on the feedback from the learners and the submission of assignments. However, compared to the learning support systems that have been widely implemented, there is still a lot of adjustment needed. We also need to use the prototype many times to understand the features required by the learners. In addition, adjusting features is assumed to lead to more factors for feedback. For example, in the reflection sheet, we now know the speed at which learners are typing Japanese with the addition of auto-save. By using new factors such as input speed, proposed system is considered to be able to return more personalized feedback.

7.2 About results of the questionnaire

We discuss three themes based on results of the questionnaire. First, the usability of our prototype is discussed. As the result of the questionnaire, we found that the interface and button layout were generally good, although there are improvements in the operation aspect. The usability of the prototype is presumed to improve further by making it easier to understand what to do next and reducing the amount of data to load. For future improvements, the prototype needs to be adjusted these while maintaining the simple UI.

Second, “Vocabulary rank”, a measure for experimental feedback, is discussed. Based on the feedback from the learners, we adjusted the prototype to show the details of each vocabulary level as a “Vocabulary List”. Therefore, they can check the difficulty level of each word. However, the results of the questionnaire indicated that less than half of the learners utilized the rank. We presumed that displaying only the rank and the list is difficult for learners to understand what it represented. For this reason, we found that the feedback should be not only numerical, but also understandable to the learners. We need to focus on how feedback is presented in the future.

And finally, speech recognition is discussed. Although the primary focus of the prototype is to transcribe speaking, speech recognition on the browser was implemented, but the function to record speaking was not. This means that learners’ answers only depend on the transcribed text. For this reason, some learners were found to redo their speaking every time some problems about speech recognition occurs, such as misrecognition of proper nouns or recognition of a different kanji character with the same sound. Relying solely on transcriptions is to be a cause of barriers to use. In the current situation, the transcribed text is displayed only as a supposed guide, and the audio needs to be collected separately.

8 CONCLUSIONS

In this paper we have reported on a preliminary experiment for developing learning support system that can provide immediate feedback to learners to practice speaking for communication that requires free speaking without restricting practice environment. Our prototype made it possible to obtain data on learners in a real practice environment while maintaining the merits of asynchronous learning that do not restrict the time and the place to learn. Moreover, the questionnaire revealed the prototype’s good points and improvements that lead to the removal of potential barriers to practicing.

At the time of writing this paper, we are running the second preliminary experiment using our prototype ver.2 improved to make it easier to understand the flow of operations while maintaining the simplicity of the user interface. In addition, the function to record and submit voice data was implemented in ver.2. Through the use of this function, we began to create a dataset of audio data paired with four levels of confidence labels selected by learners to their speaking. This dataset is set to use in an experiment to estimate the learner’s confidence from speaking. In the future, we would like to improve learners’ speaking ability and “Willingness to Communicate [17]” by providing feedback based on the estimated confidence.

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