A Field-test of a Web Application for L2 Speaking Practice under an Uncontrolled Learning Environment for a Whole Semester

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A field-test of a web application for L2 speaking practice under an uncontrolled learning environment for a whole semester

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In second/foreign language speaking practice, there is limited time for students to practice, getting feedback from an experienced teacher in class. In order to remove the time constraint, computer assisted language learning systems are the first candidate, but few systems estimate learner's state, which includes their mental states and learning environments. For estimating it, it is natural to use specific peripherals or applications, but this leads to another constraint in learning environment. In addition, it is challenging to develop such a system because speaking practice, other than practice for other skills, essentially requires non-textual data. The distant goal of this study is to propose a system that generates feedback based on learners' states, without any constraints on time and place. With this goal, the purpose of this paper is to identify the basic requirements of a system for speaking under uncontrolled learning environment by a long-term field test. In this field test, a prototype system we developed was used for 15 weeks (or 1 semester) as online assignments by 28 international students taking a Japanese language course at a university. Our prototype was a browser-based web application, and learners practiced speaking using their own devices, e.g., PCs and smartphones. This field test was conducted under uncontrolled learning environment of each learner participating in the long-term online course, without ever meeting face-to-face. These settings significantly differ from those of previous studies, which are well controlled under some specific environment. Our prototype has worked with many devices, and enabled students, including those who was not able to enter our country due to the coronavirus disease 2019 pandemic, to practice speaking. Through the field test, we identified some problems, which can be happened for similar systems of speaking, and summarized into three categories: operation devices, voice recording, and data transmission. We propose a set of methods to solve these problems, which are useful for developing similar systems in actual learning environments.

CCS CONCEPTS • Applied computing • Education • E-learning

Additional Keywords and Phrases: Web-based language learning, Second language, Speaking practice, Uncontrolled learning environment, Japanese language course

ACM Reference Format:

1 INTRODUCTION

Among the four language skills (i.e., reading, writing, listening, and speaking), speaking, in particular, is difficult to practice as a second language (L2) and a foreign language (FL). It is also a vital part of any language education classroom [2]. Hence, speaking practice has traditionally been done in the classroom where students can immediately get feedback by practicing with a teacher. An experienced teacher adapts feedback to students' personality and internal state, including language anxiety [8]. In case, however, opportunities to practice speaking in classrooms are limited since teachers find it difficult to provide individual feedback to all students due to time constraint. To solve this problem, traditional learning management systems implemented in many schools have difficulty because they essentially require non-textual data. The first candidate to solve the aforementioned problem is, a computer-assisted language learning (CALL) system for speaking. It provides a private, one-on-one environment in which learners can practice speaking at their own pace [9]. Besides, there has been no system that tried to focus or analyze learners' learning environments and behavior (hereinafter called "learners' external states") as well as learners' internal states.

The distant goal of this study is to propose a system that generates feedback based on learners' speaking inputs and estimation without any constraints on learning environment. With this goal in mind, we first focus learners' external states related with devices used for learning on an uncontrolled learning environment. Some previous studies, which proposed systems for speaking, have been conducted in a controlled environment, such as computer laboratories, which minimize external factors to evaluate the systems' accuracy and effectiveness. However, an actual learning environment is not controlled since each learner has different devices. In addition, with the spread of online learning due to the coronavirus disease 2019 (COVID-19) pandemic, time and place in learning are becoming more uncontrolled. Analysis of learners' external states requires the collection of many system logs as well as learners' answer data. It is challenging because it requires attention not only to statistical data but also to each piece of data and sometimes to identify its details through interactions with learners.

This paper aims to identify the basic requirements of such a system for speaking in an uncontrolled learning environment. To achieve this, we have conducted a field test on international students who are participating in online courses to practice Japanese speaking as an L2 for one semester (or 15 weeks) at Kyushu University in Japan. This test was conducted for a longer-term than previous studies using a prototype system without constraint on time, place, and device, and under an uncontrolled learning environment without ever meeting face-to-face.

2 LITERATURE REVIEW

In this section, we briefly see previous systems for speaking practice, and then we focus on how controlled and how long previous experiments were.

2.1 Previous systems

Firstly, we introduce four studies about CALL systems which recognize speech for practicing in L2 or FL [12–15]. These CALL systems focus on improving learners' speaking skills, which provide feedback based on grammar, vocabulary, and pronunciation assessments. However, in the design of these systems, little consideration has been given to the learners' internal and external states. In particular, [15] has basically experimented on each learner's devices, but no analysis or reference to learners' external states.

Secondly, we introduce four studies about affective tutoring system which estimate learners' internal states, not limited to speaking or language learning [3,4,6,16]. In [3,16], specific peripherals such as chair sensor, enable to estimate learners' emotions more accurate than system logs alone. On the other hand, these peripherals lead to the place constraint that limit learners' learning environment. For considering both state estimation and learning environments, we need to use only common peripherals such as camera and microphone. In [6], facial recognition and learners' text inputs generate feedback that enhances learners' motivation and interest for foreign language learning. Furthermore, [4] detects real-time uncertainty from speech signal and dialogue by speech in learning physics. Using limited data available from the common peripherals, two systems have estimated learners' internal states. However, [4] cites some room for improvement, such as a much larger dataset for improving uncertainty model. Less data available for state estimation affects range and accuracy of the estimation. In addition, these systems also focus on learners' external states.

2.2 Control and time terms in experiments

In many studies, experimental environments and participants are controlled. Experimentation in a specific environment, e.g., specific computer labs [13], allows for prior confirmation of system's operation and minimizes system errors. Even if a problem arises, experimenter can deal with it directly. As a control for participants, there is a warm-up to familiarize themselves with the systems used in experiments. This warm-up is done not only to understand the functioning of system, but also to minimize external factors in experiments, e.g., novelty factor [1]. Controlled environments are necessary to accurately evaluate an effectiveness of systems, but an actual learning environment is uncontrolled, as learners have different devices and different speeds to familiarize themselves with systems. In the studies that consider deploying system in an actual environment, it is important to validate the operation of the system with learners under uncontrolled environment.

In addition, we focus on time terms of experiments in previous studies. In previous studies, the term for which participants are asked to use the system depends on the objective, e.g., 40-60 min [6], 4-5 days [16], and 8 weeks [15]. However, the data obtained in short-term experiments are limited and it is difficult to identify many facts. [1] described long-term evaluation as future work to collect more reliable data with less influence of external factors caused by short-term settings. In studies using system, it is desirable to have learners use the system for as long as possible and collect data. Nevertheless, long-term experiments burden on participants, and cost more such as rewards, experimental management. As experimenters must set up an experiment that balances collecting data with the above issues, it is difficult to collect a large amount of data.

3 FIELD TEST

In [10], we conducted an experiment to evaluation usability of our prototype system. In this paper, we report a field-test using our prototype in [10]. We identify the basic requirements of systems under uncontrolled learning environment by focusing on the data and logs collected by our new prototype. The details of the field test summarized in this section are: (1) target course and participants, (2) our prototype system, and (3) procedure.

3.1 Target course and participants

This field test was conducted in a course named "Active Japanese" at Kyushu University. This course is one of the courses for international students at Kyushu University to learn Japanese for communication. We had to proceed with the field test without meeting face-to-face because the course was held online due to the COVID-19 pandemic. In this paper, we show the result of the field test conducted in the Active Japanese from April 2021 to August 2021.

28 international students (Undergraduate: 18, Master: 7, Doctor: 2, Assistant Professor: 1) participated this field test. Most of the participants had studied Japanese for more than one year before they took the course.

They are mainly from Asia, including China, Indonesia, and Philippines. Some participants had not been able to enter Japan due to the pandemic and attended the course from outside Japan. They chose this course for various reasons, such as to improve their communication skills, to pass Japanese-Language Proficiency Test N3, and to read Japanese manga and watch Japanese anime without translation.

3.2 Our prototype system

In this field test, we used a web application we developed since learners can use it from a browser on their PCs and mobile devices. Our prototype consists of a server with shell script and Apache2, and a web browser client (see Figure 1). Compared to an older version of our prototype in [10], this prototype is added recording function, and learners practice speaking using the microphone connected to their own device.

In the following, we show a page of speaking practice after logging in to our prototype (see Figure 2). On this page, the learners speak appropriate sentences and their own thoughts in response to the displayed instruction, examples, and questions (Figure 2(a)). There are three types of questions:

1. Pattern practice … Given an example sentence and target words or sentences, to rephrase the sentence using given words or sentences. On average, about 15 questions were added every week. See Figure 2 for an example of this type.
2. Fill in a blank in dialogue … Given a dialogue with a blank, to fill in with thematic speaking. On average, about 8 questions were added every week. For example, “A: When did you come to Japan? B: (Fill this blank about your own information) A: Oh, OK.”.
3. One minute speech … Given a topic such as learner’s specialty and future dream, to speak for one minute. 1 or 2 more questions added every week.

This page also includes features to help learners with unreadable kanji (Chinese character), such as text-to-speech and displaying ruby in hiragana (Japanese syllabary characters).

A typical flow of speaking practice is as follows: Learners record their own speaking by pressing Record button (Figure 2(b-1)). After the recording is finished, the recorded data is shown as an icon on the page (Figure 2(b-2)), and they can check their recorded voice data by clicking the icon. If they are not satisfied with their speaking, they can re-record their speaking as many times as they want. If they satisfied, then learners can submit the recorded voice data file by pressing one of four confidence level buttons. It will be used as a label of the learner’s state for supervised machine learning from their speaking. The confidence level was chosen because self-confidence is one of the key factors in willingness to communicate [7] and acquisition [5] in a second language. The learners press one of them according to their confidence level of the speaking. The answer data sent to the server is recorded in the data files, and the voice data is saved as Waveform Audio File Format (WAV) file. After these data are stored on the server, learners can check the feedback messages generated by the server (Figure 2(b-3)). In this prototype, model answer text is presented as minimum feedback. After the feedback message was displayed, learners can choose to retry the same assignment, try the next assignment, or leave.

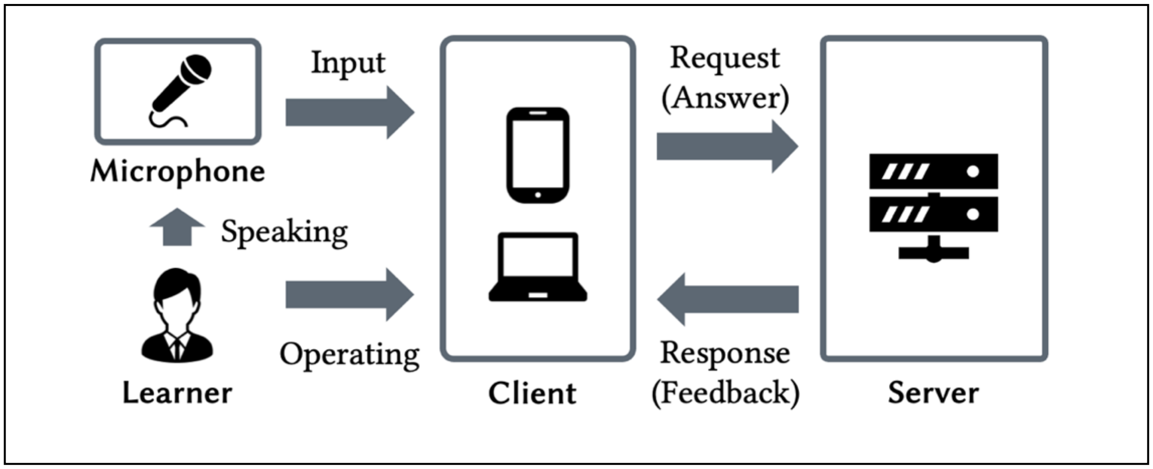

Figure 1: Components of our prototype

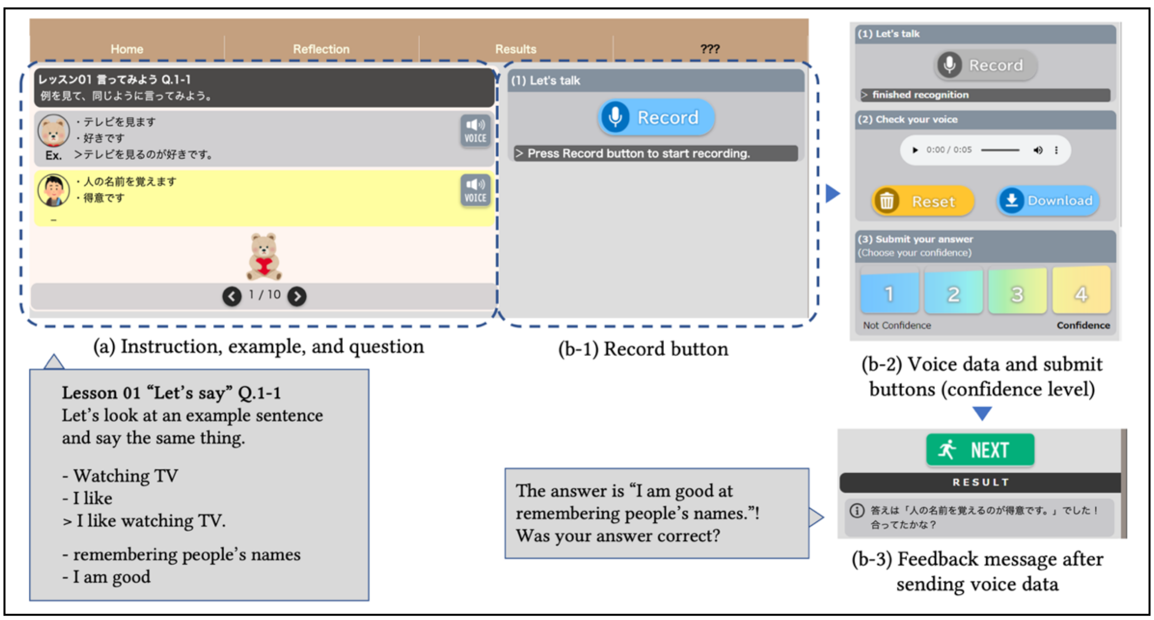

Figure 2: Flow of speaking practice on our prototype

3.3 Procedure

This field test was carried out in the following four steps:

(1) *Explanation of our prototype*. We explained how to use our prototype while sharing our PC's screen for about 5~10 minutes at the end of the first week's lecture. The instruction manual for our prototype, which was

written in English, was published on Moodle, the learning management system used by Kyushu University. Thus, the learners could check the manual at any time.
(2) *First questionnaire*. After the explanation, we published the first questionnaire on the Moodle. The purpose of this questionnaire is to obtain their consent to use anonymized data collected through our prototype for this study. The learners who answered this questionnaire received IDs and passwords to log in to our prototype from us.
(3) *Weekly online assignments using our prototype*. The learners were asked to use our prototype to practice Japanese speaking. They were able to work on the weekly assignments as much as they wanted at any time, even if each deadline is passed. We did not specify to them time or place that they use our prototype; thus, they accessed our prototype using their own devices and microphones at any time. At the end of each week's lecture, they were able to ask us about our prototype.
(4) *Second questionnaire*. Second questionnaire was conducted at the end of the last week's lecture to collect data for evaluation of our prototype and future analysis. This questionnaire was created using Google Form and published on the Moodle.

4 RESULTS & DISCUSSION

In this section, we will summarize the results and discussion of the field test in three phases: (1) operation devices, (2) voice recording, and (3) data transmission. Each phase addresses some problems that have been encountered and the requirements for systems under an uncontrolled learning environment.

4.1 Operation devices

In this field test, from many logs that were stored on our server, we have confirmed the following:

- Out of 28 learners, 26 continued to take the course until the end, and 23 practiced speaking at least once in our prototype;
- Out of 23 learners, 18 completed more than 80% of the speaking assignments;
- The devices used by the learners were different; including PC (i.e., Windows, macOS) and smartphone (i.e., iPhone, Android);
- The Learners used multiple devices from the same location and accessed from different places; and
- One of the learners who had not been able to enter Japan accessed our prototype from outside the country and practiced speaking.

From the above, the learners were able to practice speaking using our prototype even if they were using different devices, in different locations, or even outside of Japan. This is one of the advantages of using web applications.

In a web application, a server machine basically outputs a few types of logs. Our prototype output two types (see Figure 3): (1) Web server software logs record URLs of web pages accessed by web client and the type of device or browser by the software such as Apache2 or Nginx. (2) Application script logs record processes to dynamically display web pages or messages by the scripts we developed in this study. With these logs, we can analyze learners' main learning behavior and learning environments as above. If we analyze more detailed learners' external states, it is necessary to collect client logs, which have not been the focus of previous studies. It is because the aforementioned logs record processes on the server machine, not the processes that do not involve the server on the client. For example, the processes of transmission and storage of recorded voice data by the clients to the server is recorded in these logs, but the process of recording audio input from the microphone is not recorded because it is done within the client. The learner's in-client behavior recorded in this field test was limited, for example, preparation time before starting the recording voice. We can update our prototype so that processes on the client, such as the recording process, are also logged on the server machine as much as possible. Storing more learners' in-client behaviors in the server as client logs is informative for more detailed estimation of the learners' external states.

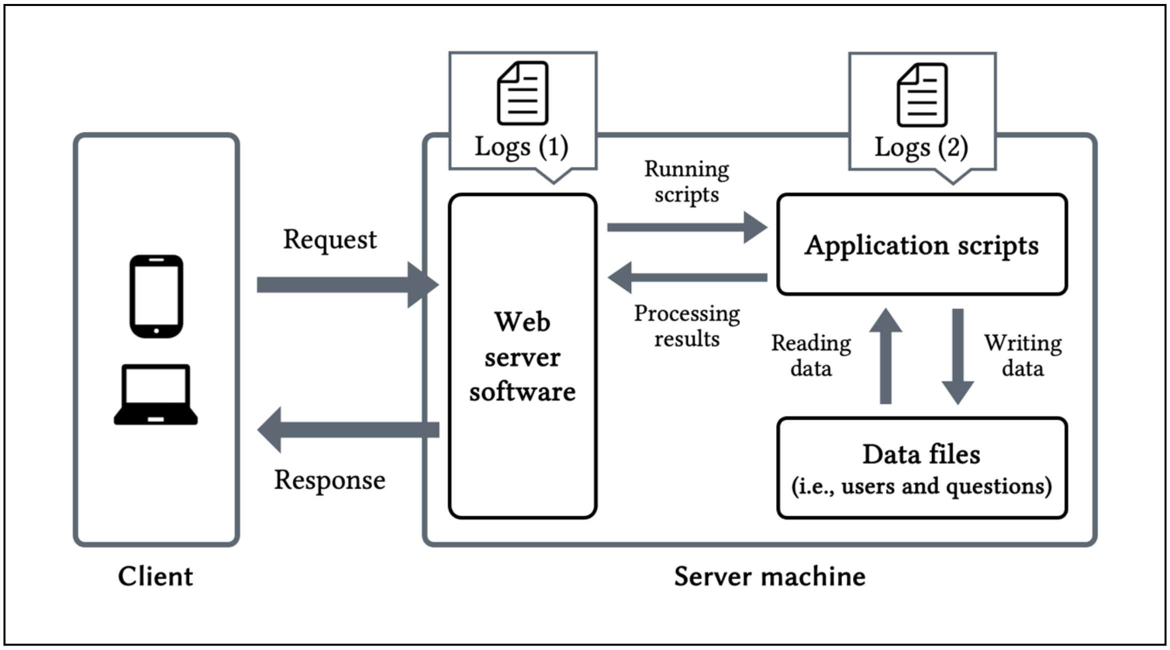

Figure 3: Two types of logs stored on our server machine

4.2 Voice recording

For our prototype, we had each learner use the microphone on their devices or an external microphone that can be connected to their devices. In this field test, we were able to identify a problem with blocking of microphone permission in browsers. One of the learners reported to us that she was unable to record her speaking. We asked her to check the microphone permission in the browser because some of the logs suggested that the microphone might not be allowed. As a result, the following logs about her showed that she was able to practice by recording her speaking. When a web page uses a microphone, the browser basically asks the user whether to permit the microphone use. A pop-up on the screen shows a button to allow or deny the action. We should consider that microphone permissions could be denied or ignored by learners who are unfamiliar with using microphones in browsers.

This problem does not occur because systems for other skills do not use microphones. Moreover, the checking operation of microphones is within the scope of experimental preparation under a controlled environment. In an online field test under an uncontrolled learning environment like this one, however, problem occurs that is outside system's operation, which need to be handled by learners. For this reason, our prototype requires the function that shares the current status of our prototype with the learners as follows: the microphone connection cannot be verified, or the microphone permission is blocked. Systems can encourage the learners to handle problems by informing the status of the system and how to handle them through the messages and functions. Therefore, to categorize errors and messages in detail, a deep understanding of client-side scripts is needed.

4.3 Data transmission

As systems for speaking practice require audio data with large data sizes, we should be concerned about data size and Internet line velocities for sending data under an uncontrolled learning environment. In this field test, some voice data that are stored on the server were cut off in the middle and not able to play until the end. Cross-checking the logs with the voice data showed a discrepancy between the size of the data that was supposed to be sent by the client and the actual size of the data sent. From the results, it can be said that this was caused by interruption of voice data transmission due to the learner moving the pages in the middle of sending the data. We have found that this was influenced by two factors.

The first is the size of voice data. Our prototype collected voice data with good sound quality, with a sampling frequency of 44.1 kHz or 48.0 kHz, for the final goal of learners' state estimation. Naturally, the better the sound quality, the larger the size, and the longer it takes to transmit. In this field test, one-minute speeches tended to have the longest audio data. For example, the data size of one learner's WAV file was 17.5MB for 90 seconds. The second is Internet line velocities. It is quite likely that it is caused by the upload speed on the client-side. In this field test, the application-side logs have shown that the processes of saving interrupted data successfully completed. In other words, our server did not interrupt the processes of saving voice data. It is notable that these logs have also shown the different speeds of the processes, which varied greatly depending on learner and timing (e.g., 284 kB/s and 12.7 MB/s). These speeds include the effect of different Internet line velocities for each learner, which makes a difference in the time that takes to complete the process. Therefore, we needed to consider how to save entire voice data on our server even in an environment with slow upload speeds.

In the middle of this field test, we added two additional processes as updates to our prototype. The first is down sampling, where, we adjusted the recording settings by referring to the sampling frequency of 16.0 kHz that is used in some corpora [11]. As a result, the time required for uploading was shortened. For example, the data size of one learner's WAV file was reduced to 2.6MB in 80 seconds. The second is sharing of transmission status, where, we added a process to our prototype that disables the button to go to the next question until voice data has been uploaded and the server has responded. In addition, a progress bar was added to visually share with learners the upload rate of their data. This allows learners to understand why they cannot move on to the next question. As a result of adding these two processes, the above problem was solved, and we were able to collect a lot of full voice data, except one data.

In this field test, the combination of multiple factors led to the problem of sending voice data. It is less likely to occur in controlled environments where line velocities do not significantly vary, or in systems that target short speeches such as words or short sentences. Under an uncontrolled learning environment, we should consider the learning environment that surround each learner, such as line velocities or microphones. This problem was identified due to a long-term field test while adding assignments with different characteristics.

We also confirmed that an advantage of long-term field test with web applications is that the processes can be immediately added and used by the learners when some problems occur.

5 CONCLUSIONS

The purpose of this paper is to identify the basic requirements for systems under an uncontrolled learning environment. We identified three requirements for systems under it, which were proposed by finding and considering the problems encountered during the three phases of using our prototype. These requirements include the collection of three logs, sharing of the system state, and consideration of the environment with poor conditions. In addition, our prototype's logs showed that each learner was accessing the system using a different device, in a different location from their usual learning environment, and in a different country. These confirm the effectiveness of an under uncontrolled learning environment, where constraints on time and place are removed.

This field test identified problems that are difficult to cause spot under controlled environment experiments or in a short term. Some of the problems were solved by fixing our prototype without stopping the field test, which required support outside the operating of our prototype. All of the support was provided through messages and question time during each lecture due to the pandemic. Experiments or field tests like this one need to carefully consider how learners can be supported.

Many of the problems encountered during this field test were specific to web applications that use microphones, that is, for speaking practice. However, the improvement methods proposed in this paper can be applied to the study of systems for other subjects and skills. In studies using systems, it is important to evaluate the accuracy and effectiveness of the main functions of the system in a controlled environment. However, it is also important to understand how external factors can cause problems in an uncontrolled learning environment. Developing a system while also paying attention to the detailed requirements mentioned above will help ensure a smooth experiment under an uncontrolled learning environment. In future studies using systems, it is important to consider whether it can be implemented in an actual learning environment. The field test results do not only identify the proposed system's direction, but also support the smooth implementation of the system into an actual learning environment that is used in related studies.

In this paper, to identify the basic requirements for systems under an uncontrolled learning environment, we have focused on the problems that occurred in the field test. It is not concerned with detailed learning behavior, voice data, and questionnaires. For future experiments, we will focus on these data collected by our prototype. Their analysis for feedback generation may identify new requirements under an uncontrolled learning environment. Besides, this field test identified some improvements in our prototype such as microphone errors and lack of feedback messages to learners. To help learners practice speaking smoothly in any uncontrolled learning environments, we need to improve our prototype. It does not only need the basic requirements identified in this study, but also knowledge of studies about systems in actual learning environments. Finally, the one-semester course, which was the target of this field test, seems suitable for examining the long-term changes in learners as indicated by the previous study's limitation. For confirming the effectiveness of feedback that is generated by systems, controlled experiments, which provide different feedback to different groups, are generally conducted. However, in this course, it is undesirable for each learner to be provided with a different content only for experimental purposes. We need to consider future experimental settings, including the time terms and location.

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