

A Video Annotation System to support Self-Reflection in Microteaching with Mobile Devices

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This study aims to propose a method to support university students' self-reflection to improve their teaching skills on portable mobile devices in an asynchronous online environment. To achieve this, we examine a method of improving teaching skills through self-reflection based on using the extension functions of the video annotation system which supports self-reflection. Therefore, we conducted a peer review of microteaching using the system with eight university students who are teacher trainees. We analyzed the results of a questionnaire for learners and the results of interviews with teacher educators. As a result, it became clear that these functions are effective as a method for supporting self-reflection for improving teaching skills for university students.

Keywords: microteaching, mobile devices, peer review, pre-service education, video annotation

Introduction

Currently, in Japan, there is an emphasis on the training of teaching practical skills in pre-service education. Thus, effective microteachings are required for lesson studies. A lesson study is an activity that helps improve lessons and teaching skills. Participants conduct joint lesson observations, discuss the evidence, and perform activities to understand the process better. Japanese lesson studies have attracted attention from around the world, particularly the feature of “self-improvement” (Hiebert & Stigler, 1999). In other words, Japanese lesson studies involve not only top-down guidance from teacher educators but also teacher training from the bottom-up by teachers themselves. Therefore, it is also necessary for university students to upgrade their teaching skills by “self-improvement” by microteaching in pre-service education.

Traditionally, lesson studies using video have been conducted in schools including pre-service education (Sherin & Han, 2004). A video annotation tool (VATool) adds information to the video (Rich & Hannafin, 2009; Colasante & Douglas, 2016). In education, the VATool enables the reconstruction of scaffolding and thinking for self-reflection in performance activities, such as class and conversion to new learning, by using annotation information in the videos (Rich & Hannafin, 2009). It is particularly effective to demonstrate lesson points using the VATool because it is easy for university students with less experience in pre-service education. Thus, the VATool is an effective video tool in lesson studies and microteaching in pre-service education.

By using the VATool in lesson studies, even without face-to-face discussions with teachers, it is possible to improve lessons and teaching skills by reviewing individual pace. Lesson studies conducted at individual pace are important, not only for teachers in schools but also for university students on teacher training courses as they have few common classes, or they may have jobs, so there are few opportunities to gather together. On the other hand, most university students today possess a mobile device and tend to learn using this device in short episodes (Sharples, Corlett, & Westmancott, 2002). Furthermore, in Japan, people are more frequently using smartphones (portable mobile devices) than personal computers. (MIC, 2018). There is a need to develop an asynchronous online learning environment on a portable mobile device to support self-improvement activities for university students in pre-service education. This will help improve effective lesson activities in subsequent lessons. Thus, there is a need to develop the systems and learning design of the VATool for university students so they can improve their teaching

skills through microteaching by “self-improvement” in an asynchronous online environment on a portable mobile device.

Theoretical background

Research exists on system development in lesson studies using the VATool in an asynchronous online environment to elicit improvement points through peer reviews (Westhuizen & Golightly 2015; Bryan & Recesso, 2006). Westhuizen and Golightly (2015) developed a system called “VideoANT” that supports the review of microteaching by sequential evaluation of text online. Bryan and Recesso (2006) developed “VAT,” which helps to specify the inconsistency of beliefs and practices in microteaching. These systems supported the gathering of viewpoints through peer review in an asynchronous online environment.

It is important for a lesson study to provide continuous improvement opportunities (Hiebert & Stigler, 1999). In addition, peer review needs to work toward continuous independent improvement (Liu & Chun, 2013). Thus, it is vital that lesson studies should improve practice in subsequent lessons, not just in the original lesson. Research exists on system development in lesson studies in an asynchronous online environment to elicit improvement points through two or more self-rehearsal (Suzuki, Nagata, Nishimori, Mochizuki, Kasai & Nakahara, 2010; Kawaguchi, Yamashita, & Nakajima, 2012). Suzuki et al. (2010) developed a system to support web-based lesson studies, and therefore this system supports detailed discussion about lessons. Kawaguchi, Yamashita, and Nakajima (2012) developed an e-portfolio system for lesson improvement and verified the effects.

However, new young teachers lack the ability to judge their own lessons and discover how to improve (Sato, 1989). This is even more difficult for university students in pre-service education. Therefore, it is necessary for university students to support methods for improving university students’ teaching skills. The usual method of improving teaching skills is to look back on one’s own actions, determining those that require improvement and replacing them with more effective teaching actions (Kometani, Tomoto, Tonomura, Furuta, & Akakura, 2014). Also, the ALACT model proposes a learning theory that can have an effect on educational activities, including the improvement of teaching skills by repeatedly going back and forth between practice and reflection (Korthagen, Kessels, Koster, Lagerwerf, & Wubbels, 2001). The ALACT model is a learning model that is designed to enable a teacher to reflect on experiences and changes in behavior through learning by the process of “Action,” “Looking back on the action,” “Awareness of essential aspects,” “Creating alternative methods of action,” and “Trial.” It is vital for university students through these actions to engage in self-reflection to realize continuous improvement in their teaching skills. Until now, these system development studies have only been able to support gathering viewpoints.

Kurata, Fujiki and Murota (2018) developed a system named “VOVAM” as a VATool to achieve peer review using portable mobile devices in an asynchronous online environment. We developed functions to promote awareness using portable mobile devices, and we are seeking to implement functions to support self-reflection. In “self-improvement” lessons in an asynchronous online environment, if we can support self-reflection, we can greatly contribute to the improvement of university students’ teaching skills. However, we have not yet investigated functions to support the improvement of university students’ teaching skills in that system during the practice of microteaching.

This study aims to propose a method to support university students’ self-reflection to improve their teaching skills on portable mobile devices in an asynchronous online environment. To achieve this, we examine a method of improving teaching skills through self-reflection based on using the extension functions of VOVAM, which supports self-reflection.

Research method and design

Learning design

The learning design of microteaching by using video annotation in an asynchronous online environment is shown in the left of Figure 1, which incorporates the process of a pre-service teacher demonstrating the lesson twice, and is based on the lesson study method by Hiebert and Stigler (1999). This activity is a practice of demonstrating a lesson by one pre-service teacher where there is nobody playing the role of the child. Furthermore, this learning is not the improvement of the content of the lesson plan but is aimed at improving the teaching skill. Therefore, the prerequisite for this learning is that the content of the lesson has been thoroughly studied in advance and there is no possibility of significant change. The learners conduct a peer review while alternately switching between the role of “pre-service teacher” and “evaluator.”

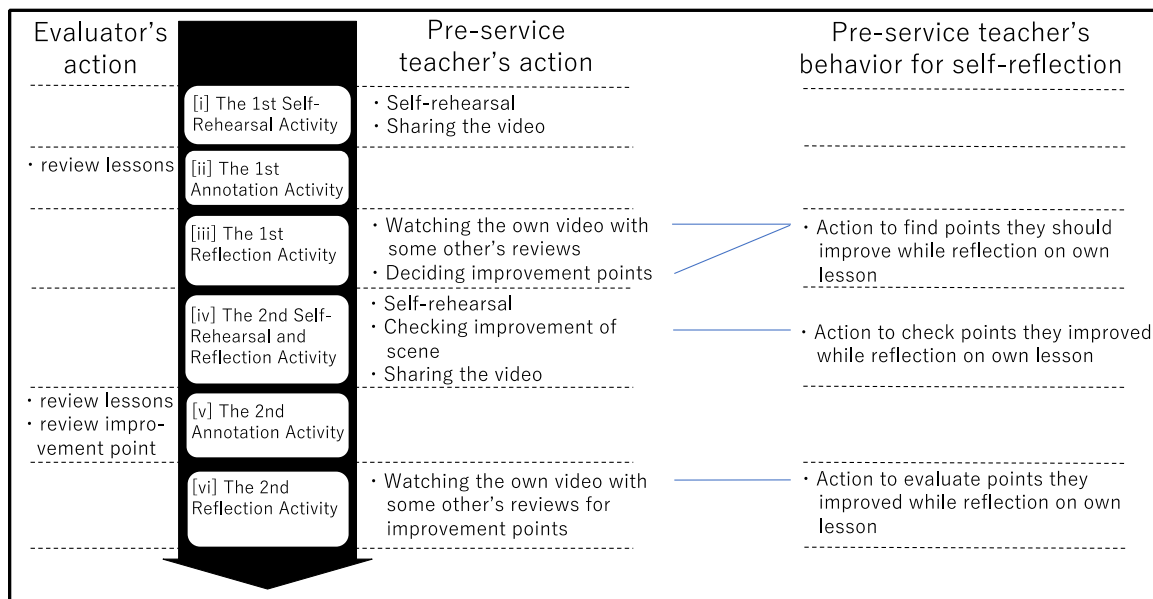


Figure 1. The learning design and self-reflection of microteaching by using video annotation in an asynchronous online environment

In this study, as shown on the right of Figure 1, self-reflection is incorporated according into the lesson design. Self-reflection in this study is based on activities related to the ALACT model: “Looking back on the action” and “Awareness of essential aspects.” More specifically, self-reflection involves considering one’s own actions objectively by “Looking back on the action.” In addition, through self-reflection, university students achieve many kinds of awareness and decide on some points they can improve through “Awareness of essential aspects.” However, it is not assumed that students can perform deep reflection on the same level as professional teachers. Therefore, in this study, we define self-reflection as reflecting on one’s own actions to improve one’s teaching skills by identifying and checking aspects that need improvement. we defined the following three scenes as the self-reflection for the improvement of their teaching skills of the pre-service teacher. To begin with, there is the first reflection activity. In this activity, the pre-service teacher judges their own points for improvement by referring to the feedback from evaluators. This resolves the lack of self-diagnostic ability of university students. Second is the self-rehearsal and reflection activity. In this activity, pre-service teachers should improve compared with the first self-rehearsal. Thus, it is necessary for the pre-service teacher to check whether the second lesson has improved compared to the first one. Third, there is the second reflection activity. In this activity, the pre-service teacher re-checks their improvement scene by referring to the feedback from evaluators.

In the first self-rehearsal activity, pre-service teachers perform a self-rehearsal of their lesson. In detail, it is a lesson delivered by one pre-service teacher using a blackboard. The pre-service teachers record the lesson and share the recorded video among the learners. In the first annotation activity, the evaluators review the lessons by watching the videos. Then, the evaluators need to explain the content of the review to the pre-service teacher accurately. In the first reflection activity, pre-service teachers reflect on their performance of their teaching skills by watching their video of themselves and checking the evaluators’ reviews. The pre-service teacher self-diagnoses the positive aspects of their teaching skills and the aspects needing improvement in their first self-rehearsal. In the second self-rehearsal and reflection activity, the pre-service teacher, first, performs a self-rehearsal again and records. Then, the pre-service teacher reflects by watching their video of themselves while checking whether it shows improvement compared to the previous lesson. Then, the pre-service teacher shares the recorded video with other learners. In the second annotation activity, the evaluators review the lesson by watching the video of the second self-rehearsal. Essentially, this is the same as the first annotation activity. However, the evaluators need to explain whether the teaching skills have improved in comparison with the previous one. In the second reflection activity, the pre-service teacher views and reflects on the video of their second self-rehearsal while checking the evaluators’ reviews. In this activity, the pre-service teacher checks if the teaching skills have improved by referring to the evaluation of the second lesson.

System design

The VOVAM system has functions to support each activity in microteaching using video annotations in an

asynchronous online environment with portable mobile devices. In the first self-rehearsal activity, this system supports the sharing of videos recorded by other learners. In addition, in the second self-rehearsal and reflection activity, this system allows the pre-service teacher to check whether the second performance is better than the previous one. To support that activity, we implemented “the lesson-scene-link function.” In the annotation activity, this system allows the evaluator to review lessons easily and accurately using a portable mobile device. To support this activity, we implemented a function allowing review by drag and drop. In addition, despite being the second activity, this system allows this activity to be evaluated while comparing lesson scenes before and after improvement. To support this activity, we implemented “the improvement-scene-notification function.” In the reflection activity, this system allows the pre-service teachers to reflect on their own performances by watching the video while confirming the evaluators’ reviews. Furthermore, this system allows the pre-service teacher to record his or her own improvement points by referring to the evaluators’ reviews. before the next lesson. To support this activity, we implemented “the marker-overlap-playback function.” Thus, the marker-overlap-playback function, the lesson-scene-link function, and the improvement-scene-notification function support self-reflection for the improvement of their teaching skills.

Features to support self-reflection for improvement of teaching skills

We implemented three functions in VOVAM to support self-reflection for improving teaching skills. These are the marker-overlap-playback function, the lesson-scene-link function, and the improvement-scene-notification function.

The marker-overlap-playback function is displayed in Figures 2 and 3. The marker-overlap-playback function supports the pre-service teacher in identifying aspects that need improving that one university student alone might hardly notice, by displaying the opinions of some evaluators on the self-rehearsal video screen. In addition, this function supports the student’s capability to self-determine aspects that need improvement by selecting evaluators’ opinions and registering them in the system. It leads to look back on one’s own actions, determining those that require improvement (Kometani et al, 2014). In detail, this function supports reflection activities with portable mobile devices and has three main features. the first feature involves displaying the translucent marker by overlapping it on the video screen in synchronization with the target position and timing annotated by the evaluators during video playbacks. Thus, pre-service teachers can understand the target position and timing on each marker during video playbacks. Additionally, the pre-service teacher can check the overlapping part of the video by making the marker translucent. Moreover, we implemented the marker gradually from transparent to translucent over three seconds according to the timing of the evaluator’s annotations. The reason for this is that when the marker is displayed for a short time, the evaluation information is hidden before the pre-service teacher can understand the content. This function aggregates and displays evaluation content from all the evaluators. Therefore, markers might overlap and be displayed as shown in Figure 2. The second feature involves displaying comments under the video screen in synchronization with the marker display during video playbacks. Therefore, pre-service teachers can understand comments on each marker during video playbacks. Serial numbers are displayed in circles and at the beginning of comments by text to correspond to markers and comments. The third feature allows the self-diagnosis and recording of improvement points from among the displayed markers (recording of evaluation). Thus, pre-service teachers can record improvement points with reference to the evaluators’ reviews. For this reason, it is possible to help university students in their self-diagnostic activities by allowing activities that record feedback from multiple evaluators.

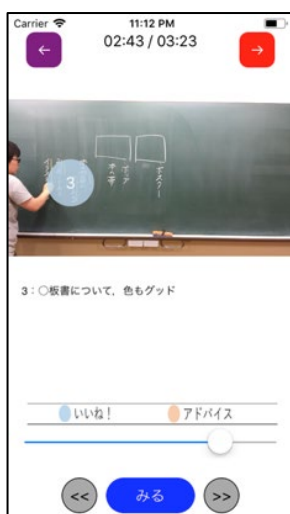


Figure 2. The screen of the marker-overlap-playback function

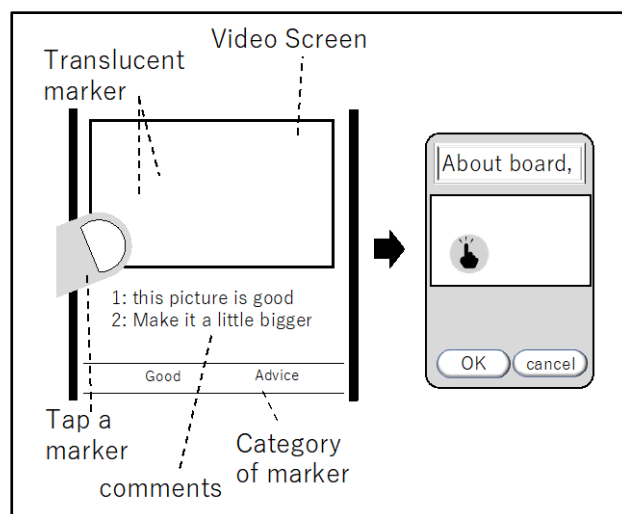


Figure 3. The contents of the marker-overlap-playback function

The lesson-scene-link function is shown in Figures 4 and 5. The lesson-scene-link function supports the second self-rehearsal and reflection activities. In order to check whether the second self-rehearsal has improved compared to the previous one, the pre-service teacher needs to be aware of the differences before and after the lesson. Therefore, this function supports reflection by comparing the aspects that have improved in the lesson scenes through using the first and second self-rehearsal videos. Furthermore, by displaying a list of all the points requiring improvement that have been recorded during self-reflection, this function can support preventing unconfirmed about improvement points. It enables a pre-service teacher to reflect on experiences and changes in behavior (Korthagen et al, 2001). In detail, this function supports the second self-rehearsal and reflection activity on portable mobile devices and has three main features. The first feature involves displaying the improvement points as self-diagnosis by the pre-service teacher in a list (list of improvement points). The pre-service teacher can then understand what they should improve on in the second lesson. To understand the improvement points visually, the content of the list display has been made into a thumbnail of a screenshot of the improvement scene and a marker from the evaluator. Furthermore, to confirm the details of the lesson scene before improvement, pre-service teachers can watch videos for 10 seconds from the 5 seconds mark before the improvement scene. The second feature involves watching videos of the lesson scenes after improvement while confirming the improvement points (watching video while checking). Thus, pre-service teachers can compare the first and second lesson scenes. To compare two lesson scenes on a small screen, the part related to the lesson scene after improvement is displayed on the upper half of the screen, and the part before improvement is displayed on the lower half of the screen. The third feature involves a self-analysis of the improvement points through activities linking the scenes before and after improvement (confirming improved scene). Therefore, pre-service teachers can check what has improved in the second lesson.



Figure 4. The screen of the lesson-scene-link function

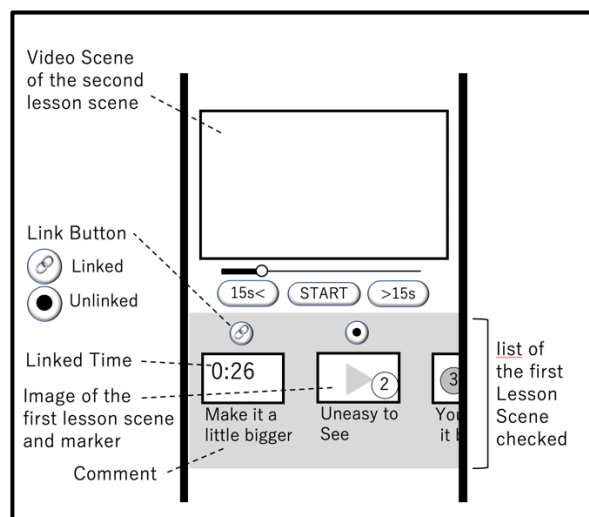


Figure 5. The contents of the lesson-scene-link function

The improvement-scene-notification function is shown in Figures 6 and 7. The improvement-scene-notification function supports the second reflection activity. This function enhances the self-reflection in the second reflection activity by supporting the annotation activity by the evaluators that leads to the second reflection activity. The second annotation activity provides different support than the first annotation activity because, even if there is something to be noted like aspects for improvement, learners may miss it (Reiser 2004). In other words, if there is no review of the aspects requiring improvement in the annotation activity performed before the second reflection activity, the pre-service teacher cannot evaluate whether the contents improved are good or bad. The improvement-scene-notification function supports the evaluators in reviewing the improved behavior by notifying them of the timing of the scene in which the pre-service teacher improved during the second annotation activity. In detail, the improvement-scene-notification function supports the second annotation activity and has two main features. The first feature involves automatic notification of an improving scene during video playback (timing of improved scene). Therefore, the evaluators can watch the video without overlooking the improvement points. Since the evaluator can confirm the lesson scene before improvement during video playback, the lesson scenes are displayed for 3 seconds from the 2 seconds mark before the timing of an improving scene. The second feature involves knowing whether the lesson scene before improvement has become an improvement scene during video playback (comparison of the scene before improvement). Thus, evaluators can assess an improvement scene while checking the lesson scene before improvement. To compare two lesson scenes on a small screen, an image of the lesson scene before improvement is displayed as a thumbnail and there is a comment at the top of the screen.

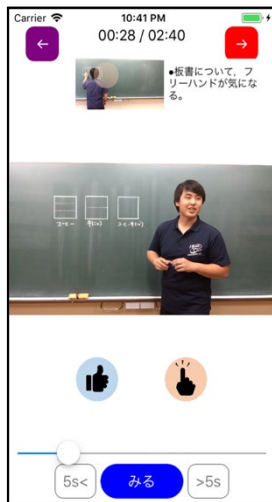


Figure 6. The screen of the improvement-scene-notification function

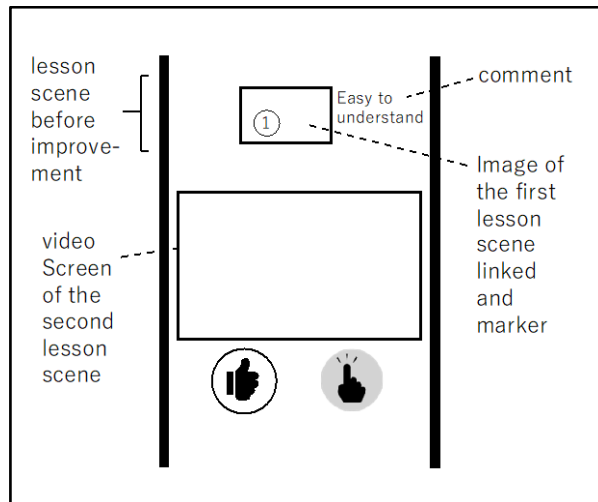


Figure 7. The contents of the improvement-scene-notification function

The markers for microteaching are shown in Figure 8. The learning target of this system is microteaching. For this reason, we made it possible to utilize the markers as video annotation tools for evaluation in peer review of microteaching. As a result, we created six categories based on the evaluation points of microteaching (Mio & Makino 2010). In VOVAM, since the screen size of the portable mobile devices is small, there are the markers always displayed and the markers not always displayed. We implemented two types of markers—good and advice—which are always displayed on the screen. In addition, we implemented six categories as shown in Figure 8: voice, blackboard, pre-service teacher’s behavior, timing, ease of understanding, and other markers, which are not always displayed on the screen. The evaluators can drag and drop the “good” or “advice” markers to the target position on the video screen according to what they want to highlight. The evaluators drag and drop the marker onto the video screen, and then the markers for viewpoints appear. The evaluators tap to select a marker, then a window for comment input is displayed so they can input comments as text.

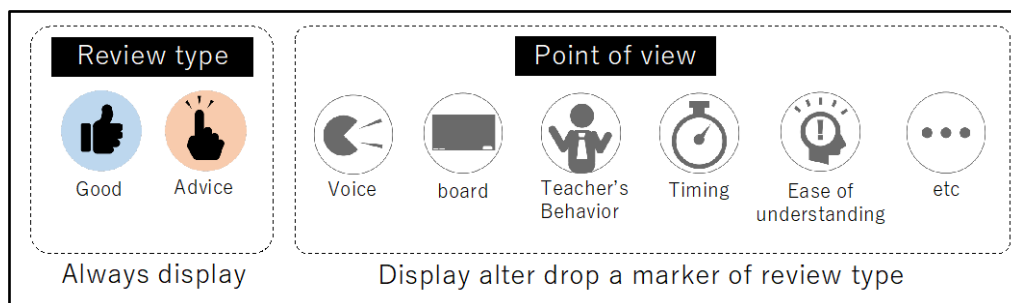


Figure 8. The markers for evaluation

Experimental design

The participants were eight undergraduate students in fourth-grade teacher training courses, and two groups of four people were formed. The practice was conducted according to the learning design in Figure 2. In detail, we set the self-rehearsal activity for three days, the annotation activity for two days, and the reflection activity for two days. In the learning design, each activity is conducted twice, so there was a total of two weeks of practice. Over the two weeks, participants could practice anytime and anywhere. However, we conducted an orientation for 90 minutes on the first day only as we needed to share the content of the practice and show participants how to operate VOVAM. The content of the microteaching conducted by the participants was an introductory lesson from “elementary school mathematics (fifth grade)” and the unit was “heterogenic denominator fractions.” The demonstration time for the microteaching lasted about five minutes. The equipment used was an iPod Touch with a screen size of four inches. In addition, VOVAM was installed on this equipment.

We conducted two kinds of investigations in this study. The first one involved a questionnaire for participants after their practice. The content of the questionnaire is shown in Table 1. The aim of this questionnaire is to obtain

subjective evaluations from the participants regarding the functions of the system supporting self-reflection. Therefore, we targeted the three functions of the marker-overlap-playback function, the lesson-scene-link function, and the improvement-scene-notification function. Then, we conducted a subjective assessment of the features of the functions and the operability of each function. We conducted the questionnaire based on a four-point Likert scale (4 = Strongly Agree, 3 = Agree, 2 = Disagree, 1 = Strongly Disagree). In addition, we added a free description column to the questionnaire sheet for more feedback about using each function. The second investigation is an expert review related to teacher educators about the system's functions that are conducted. The aim of this expert review is to examine whether the functions of the system contribute to improving the lessons of university students. Thus, we conducted a semi-structured interview among teacher educators who are delivering teacher training on the function of the system to support self-reflection. These questions are "Do you think that the marker-overlap-playback function can support self-reflection for improvement of teaching skills by university students?", "Do you think that the lesson-scene-link function can support self-reflection for improvement of teaching skills by university students?", and "Do you think that the improvement-scene-notification function can support self-reflection for improvement of teaching skills by university students?". Also, in order to obtain many kinds of review, three teacher educators reviewing each made a different career. In detail, experts are an elementary school teacher teaching of the interns at the elementary school attached to the faculty of education (expert A), a researcher at the faculty of education with a career at the school field (expert B), and a researcher involved in teacher training at university for a long time (expert C). We conducted this interview in December 2018. First, teacher educators experienced the functions of VOVAM. Then, we showed them what kind of self-reflection could be done in practice. After that, we interviewed teacher educators about whether the functions for lesson improvement can support university students in improving their lessons.

Table 1

The items of the questionnaire

Category	No	Contents
The items about the marker-overlap-playback function (related to self-reflection)		
recording of evaluation	1	While watching video in the reflection activity, I could record improvement points by selecting markers.
usability of marker-overlap-playback function	2	It is easy to operate in the first reflection activity on a portable mobile device.
The items about the lesson-scene-link function		
list of improvement points	3	In the second self-rehearsal activity, I understood the improvement points from the displayed list.
watching video while checking	4	In the second self-rehearsal activity, I could watch videos of the second lesson scenes while checking the improvement points.
confirming improved scene	5	In the second self-rehearsal activity, I could confirm where I improved in the second lesson.
usability of lesson-scene-link function	6	It is easy to operate in the second self-rehearsal and reflection activity with a portable mobile device.
The items about the improvement-scene-notification function		
timing of improved scene	7	While watching the video in the second annotation activity, I understood the timing of the improved scene.
comparison of the scenes before improvement	8	While watching the video in the second annotation activity, I could evaluate and understand the contents before improvement.
usability of improvement-scene-notification function	9	It is easy to operate in the second annotation activity on a portable mobile device.

Results and considerations

The effects of the marker-overlap-playback function

We conducted a questionnaire to obtain a subjective assessment from university students on the marker-overlap-playback function. Results of the questionnaire about this function are shown in Table 2. We classified strongly agree and agree as positive, disagree and strongly disagree as negative, and analyzed the data with a binomial test (one-tailed test). As a result, the number of participants with positive opinions was high compared to the number of participants who held negative opinions (recording of evaluation: $p = 0.00$, the usability of the marker-overlap-playback function: $p = 0.03$). Moreover, in the comments of the questionnaire, the following was stated, "It is very easy to understand because words are displayed in the scene where I should improve my lesson." From the above, it can be said that

university students felt that the marker-overlap-playback function was effective for self-reflection.

To clarify self-reflection using the marker-overlap-playback function, we analyzed the number of markers and the number of records of improvement points in the first reflection activity. There was an average of 13.4 markers per pre-service teacher in the first reflection activity. There was an average of 4.9 markers registered as improvement points per pre-service teacher.

We analyzed the results of the expert review to the question: “Do you think that the marker-overlap-playback function can support self-reflection for improving teaching skills by university students?” The results showed that all the experts held the opinion that this function is necessary for self-reflection to improve teaching skills. A positive opinion was expressed as “For university students with a poor experience in giving a lesson, it is effective to obtain improvement points through the feedback of others (expert B).” This means that getting some other students’ opinions can lead to identifying aspects that can be improved. Therefore, it can be said that it is an effective method to support self-reflection in order to improve the teaching skills of university students. An improvement opinion was expressed as “It is even more convenient if the pre-service teacher is able to record the contents not in others’ evaluation as an improvement point (expert C).” We thought that the reason for this opinion was that the pre-service teacher could register some students’ opinions as improvement points, but that the pre-service teacher could not select improvement points other than students’ viewpoints. In other words, it may be a more effective reflection activity if this function can support pre-service teachers in identifying improvement points from other than students’ opinions. There was also another opinion regarding improvement in terms of usability: “It would be better if the evaluation point of view was known at a glance (expert C).” Based on this, it can be said that there is room for improvement in the display of the six types of evaluation viewpoints.

Table 2

Results of the questionnaire about the marker-overlap-playback function

Category	No	Positive(N)	Negative(N)	Biomial Test
recording of evaluation	1	8	0	p = 0.00, **
usability of marker-overlap-playback function	2	7	1	p = 0.03, *

The effects of the lesson-scene-link function

We conducted a questionnaire to obtain the subjective assessment of university students on the lesson-scene-link function. Results regarding this point are shown in Table 3. We classified strongly agree and agree as positive, disagree and strongly disagree as negative, and analyzed the data with a binomial test (one-tailed test). As a result, the number of participants with positive opinions was high compared to the number of participants who had negative opinions (list display: p = 0.00, watching video while checking: p = 0.00, confirming improved scene: p = 0.00, the usability of lesson-scene-link function: p = 0.00). In the comments of the questionnaire, the following opinion was expressed, “it is especially good that I could see the last lesson as a video when linking.” From the above, it can be said that university students felt that the lesson-scene-link function was effective for self-reflection.

We analyzed the results of the expert review regarding the question: “Do you think that the lesson-scene-link function can support self-reflection for improving teaching skills by university students?” The results showed that all the experts held the opinion that this function is necessary to self-reflection for improving teaching skills. These positive opinions were expressed: “Pre-service teachers can check without overlooking one improvement point (expert C)” and “There is an effect as pre-service teacher self-reflection (expert B).” Based on these results, in the second self-rehearsal and reflection activity, it appears that the teacher can surely reflect without missing and aspects that need improvement. In addition, we thought was possible for the pre-service teacher to objectively confirm the points requiring improvement by comparing and reflecting on the lesson scene before and after working on improvement in the video image, which led to the pre-service teacher’s self-monitoring. Therefore, the lesson-scene-link function can support self-reflection while checking improvement points in the second self-rehearsal and reflection activities. An opinion on improvement was the following: “I think that it is still better if there is an activity in which the learner outputs the intention or thought about the improvement content (expert C).” It can be said that it is because there is no scene that expresses an idea through text about improvement points in this study. We thought that abstract conceptualization is necessary for deeper reflection. If we aim to train more advanced teachers, we need to incorporate such activities.

Table 3

Results of the questionnaire about the lesson-scene-link function

Category	No	Positive(N)	Negative(N)	Biomial Test
list of improvement points	3	8	0	$p = 0.00, **$
watching video while checking	4	8	0	$p = 0.00, **$
confirming improved scene	5	8	0	$p = 0.00, **$
usability of lesson-scene-link function	6	8	0	$p = 0.00, **$

The effects of the improvement-scene-notification function

We conducted a questionnaire to obtain the subjective assessment of university students on the improvement-scene-notification function. Results of the questionnaire about this function are shown in Table 4. We classified strongly agree and agree as positive, disagree and strongly disagree as negative, and analyzed the data with a binomial test (one-tailed test). As a result, the number of participants with positive opinions was high compared to the number of participants who had negative opinions (timing of improved scene: $p = 0.00$, comparison of the scenes before improvement: $p = 0.03$, the usability of the improvement-scene-notification function: $p = 0.00$). In the comments of the questionnaire, the following opinion was expressed, “Link (the lesson scene before improvement) was displayed when doing the second evaluation, so it was good because we could compare before and after the improvement.” Therefore, it can be said that university students felt that the improvement-scene-notification function was effective for self-reflection. On the other hand, there was a problem with the improvement-scene-notification function. In the comments of the questionnaire, the following opinion was stated, “since the display of the link disappears quickly, it would have been better if it had been displayed a little longer.” This means that three seconds, the display time of the scene before improvement, is too short for the learner. Therefore, the improvement-scene-notification function requires further ideas regarding “comparison of scenes before improvement.”

To clarify the situation before and after the lesson improvement, we compared and analyzed the type and number of markers recorded in the first and second annotation activity. For one pre-service teacher, there was an average of 9.4 markers in the second annotation activity compared to 13.4 markers in the first annotation activity. Furthermore, there was an average of 8.9 “good” markers and 4.5 “advice” markers in the first annotation activity. Moreover, there was an average of 8.5 “good” markers and 0.9 “advice” markers in the second annotation activity. Thus, the number of advice markers in the second annotation activity tended to decrease against the number of markers in the first annotation activity. This result shows that the advice markers from the first activity decreased in the second activity.

We analyzed the results of the expert review to the question: “Do you think that the improvement-scene-notification function can support self-reflection for improving university students’ teaching skills?” The results showed that all experts held the opinion that this function is necessary for self-reflection in order to improve teaching skills. Positive opinions were that “It is good that the before improvement scene display can be compared before and after improvement (expert C)” and “this function to evaluate and review improvement scenes is good (expert A).” This means, that in the second annotation activity, the evaluator can review without missing the improvement scene while comparing the lesson scenes before and after improvement. In other words, this function can support a review by evaluators of the improvement aspects that they consider important for the second reflection activity. An opinion on improvement was expressed in this way “If you have an overall evaluation as well as sequential evaluation, you can look back at the overall perspective (expert A).” This result can be said to indicate that not only a formative evaluation but also a comprehensive evaluation is important in order to improve lessons from a broader perspective. Another opinion on improvement was the following: “It is still better to see not only the still picture of the previous lesson but also the video (expert C).” It is because the evaluators cannot check a video image due to the information before improvement being displayed only in a thumbnail still image and the comment. Therefore, it can be said that displaying the lesson scene before and after improvement in the second annotation activity leads to a higher quality review.

Table 4

Results of the questionnaire about the improvement-scene-notification function

Category	No	Positive(N)	Negative(N)	Biomial Test
timing of improved scene	7	8	0	p = 0.00, **
comparison of scenes before improvement	8	7	1	p = 0.03, *
usability of the improvement-scene-notification function	9	8	0	p = 0.00, **

Conclusion

In this study, in order to propose a method to support university students' self-reflection for improving teaching skills on portable mobile devices in an asynchronous online environment, we examined the method of self-reflection for improving teaching skills through the practice of using the extension functions of VOVAM, which supports self-reflection.

- The marker-overlap-playback function is effective as a method for supporting self-reflection for improving teaching skills for university students because it can support finding and determining an aspect needing improvement based on the opinion of the evaluator. However, there is room for enhancing the function to allow for a wider selection of aspects for improvement.
- The lesson-scene-link function is effective as a method for supporting self-reflection for improving teaching skills in university students because it can support checking before and after efforts at improvement while comparing the scenes before and after attempts to improve.
- The improvement-scene-notification function can support evaluators in reviewing the improvement scene without missing it, which leads to the promotion of the review on the improvement point, and is effective as a method of supporting self-reflection for university students to improve their teaching skills.

In future research, in order to encourage further deep reflection, abstract conceptualization, overall evaluation, and improvement of system usability are also necessary. We will also investigate how an enhanced learning design and system can improve the teaching ability of university students.

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