Abstract

In learning, engagement refers to the participation and involvement of learners. As learners' engagement increases, the effectiveness of learning increases and can lead to improved grades.

Recently, due to the coronavirus outbreak, online education has been expanding, and its importance is increasing. In addition, with the development and dissemination of smart devices, many people can benefit from online education. Many schools and educational institutions are conducting education in the form of online classes and face-to-face classes.

In face-to-face education, teachers and learners interact directly. Teachers can see and judge the learner's condition directly, give feedback to the learner, or improve the class by quickly determining whether the learner is struggling.

Unlike face-to-face education, online education may lack learners' interactions, such as teachers quickly grasping the learner's condition and giving feedback. Therefore, in online education, learners' engagement decreases leading to decreased learning effectiveness. Securing engagement and improving the quality of instruction in online education is an important task.

To improve the learner's engagement in class, learners must participate independently.

Engagement consists of three elements: behavioral, emotional, and cognitive, of which behavioral engagement is related to learners' observable behaviors, such as participating in class or submitting assignments. Studies have shown that when learners use metacognitive strategies that understand and control their learning process, behavioral engagement increases, which positively affects test results. To increase these behavioral engagements, that is, for learners to participate in class independently, the role of teachers in the progress of the class is important. Teachers need to understand whether learners have difficulties or have lost interest in class and respond by giving detailed feedback to learners or improving classes. However, it is difficult for teachers to check learners' learning status in online education.

As an element in which learners participate in class in online classes, there is a process in which learners watch and learn lecture slides while taking notes. Watching lecture slides or taking notes with interest in the part the teacher is teaching can be actively participating in learning.

Recently, learning using tablet PCs and stylus pens has attracted attention in the field of education. Tablet PCs have high portability and flexibility to easily access any learning materials. In addition, learners can view textbooks or lecture materials on a tablet, take notes, store information, and review them on various tools such as computers and smartphones. With the digitization of education, tablet PCs are used in digital education to distribute tablet PCs to students in schools or educational fields and use them in classes.

Therefore, this study developed the system assuming learners read lecture slides using tablet PCs while taking online classes and learn by taking notes. The engagement can be identified by measuring learners' learning information, and the class can be expected to improve.

As the basis for estimating learners' engagement, three types of information were used: the amount of note-taking by the learner, the mismatch distance between the slide taught by the teacher and the slide of the learner, and the mismatch time. In the class, three types of information were measured in real-time: the amount of note-taking, the mismatch distance, and the mismatch time the information was visualized, provided to the teacher, and identified learners' engagement. The teacher developed a system that can grasp the visualized learners' engagement and provide feedback to learners in real-time or improve the class.

To visualize learners' data in real-time during class, two graphs of, "Bubble Chart" and "Slice series graph," were produced. The bubble chart contains all three types of information: the amount

of note-taking, the distance of mismatch, and the time of mismatch, and allows learners to check the individual information of each learner. The Slice series graph shows learners' average amount of writing and mismatch time per slide that conducted the lecture, allowing the teacher to understand where learners' engagement has deteriorated. In addition, the function of giving feedback to learners through the system from the information in the graph was implemented, allowing teachers to give feedback through the system.

The experiment was conducted by gathering 11 graduate students, and the graduate students divided roles into teacher roles and learner roles. However, in the class, the video lecture was played, and the subject in the teacher role only worked to grasp the learner's condition and give feedback. For comparison with face-to-face classes, the experiment was conducted face-to-face.

As a result of experimenting with the system, it was found that there was an improvement in class for both learners and teachers. However, in the case of learners, the magnitude of the effect was small, and some learners did not feel the effect. In the case of teachers, the subjects felt the effects of grasping learners' engagement and improving feedback very greatly in class. These results suggest that using the system positively affects learners' engagement and that teachers can evaluate learners' engagement to give feedback more effectively and improve instruction.

As a specific problem that the subjects responded to, it was analyzed that learners needed to improve the frequency of feedback or the content of messages sent by the system. They specifically answered that the feedback message needed a message tailored to each learner's condition, and that additional functions were needed to increase concentration. Teachers answered that they would like to make the visualized graph easier to see, and that it would be nice to automate the feedback in the system to provide feedback to individual learners and reduce the burden on teachers. They also answered that it is necessary to improve the manipulation or ease of system interfaces in common with learners and teachers.

In this study, an online learning support system was developed and the effectiveness was verified through experiments. However, there are some limitations. The number of subjects was small, so statistical analysis could not be performed, and the reliability was poor. In addition, there are improvements to the system, such as personalized feedback or ease of use of the system. In future research, improving the ease of the system, adding convenient functions, and conducting classes with more subjects is necessary.