Development of Nudge System: To Nudge Other Students Through Their Tablet

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Abstract. We develop a system that students can use to nudge other students thought their tablet, thus developing self-regulation learning skills during class. This paper presents the nudge system functions and interface design. A key feature of the nudge system is its division into four components: note taking, learning log collection, visualization of learning, and learning log confirmation. The note-taking function enable learners to write, delete, and underline notes directly on distributed materials. The visualization function of learning from distributed materials is related to the lesson (.pdf) that has been sent to the tablet device; when multiple learners take notes or underlines the same materials, the approximate section of the materials on other learners' tablet devices can be highlighted in color. As more learners take notes in the same section, the section color becomes darker. We think that this function will enable learners to use reflection, forethought, and performance assessment to evaluate their own learning strategies during class. The learning log collection function collects contents written on the class materials by hand. Additionally, the learning log collection function records to the note completion of the learners. The learning log confirmation function enables the teacher to see the note-taking process of all of the learners after class.

Keywords: Self-regulated learning · Note-taking · CSCL · Nudge

1 Introduction

Self-Regulated Learning (SRL) is cyclical and comprises situations in which learners receive feedback on their own learning. Through this feedback, learners then use meta-cognitive, motivation, and learning strategies to improve their own learning processes (Zimmerman 2001). SRL involves the following triadic processes (see Fig. 1): fore-thought, performance, and reflection (Zimmerman 2000). During the forethought phase, the learner spends considerable time thinking and planning, and individuals both analyze the task ahead and motivate themselves to act by what they believe about themselves and their situation. During the performance phase, self-regulation involves monitoring one's own thoughts and behaviors within given performance contexts and

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selecting or modifying one's strategies. During the self-reflection phase, the learner reviews the outcomes of their efforts and the behaviors that led to them, and searches to make attributions for what has happened (Usher and Schunk 2018). Schunk and Zimmerman (2008) have suggested that the advantages of being a good self-regulator include being able to: (a) set better learning goals, (b) implement more effective learning strategies, (c) monitor and assess one's own goal progress successfully, (d) seek assistance occasionally, and (e) adjust strategies more efficiently. Consequently, teacher should provide learning environments and supportive intervention in order to facilitate the cyclical process of SRL.

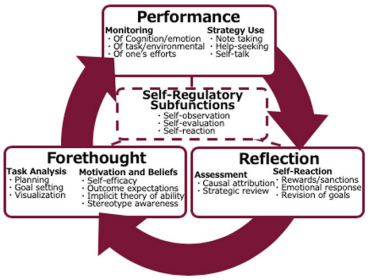

Fig. 1. Cyclical process of SRL

In relation to mathematics and SRL, Corte et al. (2000) states that the ultimate goal for people learning mathematics is to become adaptive competence learners. Adaptive competence learners gain the ability to apply meaningful mathematical knowledge and skills both flexibly and creatively in a variety of contexts. For example, in the problem-solving process in mathematics, learners not only use conventional methods but also seek new ones. Corte and Verschaffel (2006) perceives SRL skills as an important factor in acquiring adaptive competence. As a result of such findings, students clearly need SRL skills to learn mathematics and become adaptive learners. However, Schunk (2001) notes that students do not become self-regulated learners voluntarily or automatically. In other words, they become self-regulated learners as a result of help from others. Based on these findings, it is necessary to implement instructional designs in which the teachers stimulate SRL in school environments and train students to become self-regulated learners.

Zimmerman et al. (1996) introduced five viewpoints through which learners could be conscious of their own learning improvement: (a) planning and using study time more effectively, (b) understanding and summarizing, (c) improving methods of note taking, (d) anticipating and preparing better for examinations, and (e) writing more effectively. These can facilitate learners to become proficient in SRL skills via support from their teachers. Through these, learners can observe their current study practices more accurately, ascertain for themselves which study methods are ineffective and replace them with better ones, and be more personally aware of their improved effectiveness. Therefore, when the teacher develops the SRL skills of students, it is

necessary to promote their ability to self-regulate their learning via these five viewpoints and to establish a complementary teaching environment and teaching methods.

Note-taking is defined as taking notes and underlining notes, distributed material, and texts by learners in instructor-learning situations, such as during classes and while reading texts (Kobayashi 2000). Di Vesta and Gray (1972) divided note-taking into encoding and storage functions. Kiewra (1989) says that note-taking and reviewing actions facilitate understanding and memory of knowledge. The encoding function facilitates recognition processing by combining the teaching contents with the prior knowledge of the learner through writing notes. The storage function enables effective review by writing notes. With respect to note-taking, Kiewra (1989) has suggested that it is not possible to write a complete note during a class because of the speed and density of classes. On the other hand, it is also suggested that learners can easily narrow down the gist of a class when the teacher distributes the lesson materials in which the outline of the class is written, with learners thus able to take notes on the materials. In terms of understanding the content, Avval et al. (2013) showed that learners promote their understanding of the class by taking notes on the distributed lesson materials. On the basis of these facts, it is necessary to design a class in which the teacher distributes materials describing the lesson contents to learners, with the learner then taking notes on the materials during class.

Zimmerman et al. (1996) showed that exchanging notes with others during class help to develop a learner's SRL skills. Learners can review their learning strategies, set goals, and implement them with help from others. In this way, the development of SRL skills requires new learning experiences, as new skills are required after clarifying the limitations of existing strategies. Therefore, receiving assistance, such as feedback from another person, is one of the strategies of SRL (Zimmerman 2001). In addition, there is a gradual level for the development regarding learners' ability to self-regulate their learning, and external approaches and supports are necessary in the early stages of development (Zimmerman 2000). Teachers play an essential role in the instructional design, enabling learners to receive feedback from during class in order to help them develop SRL skills.

Molnar and Lukac (2015) suggested that the Internet provides a variety of educational portals and interactive applications designed to support active learning. In recent years, the schools that provide Information and Communication Technology (ICT) facilities, such as computers, large presentation devices, ultra-high-speed Internet, and wireless LAN, has increased in terms of Japanese secondary schools. In particular, high schools that have already adopted ICT-based forms of education have implemented classes using applications offering electronic blackboards and tablet terminals. As an example, LoiLoNote—an application software application available on a tablet terminal—offers a flipped classroom, making it possible to collect homework from learners before a class, return it, and provide feedback to the student by adding comments. In this way, feedback has been effectively provided to learners by utilizing ICT equipment. However, providing immediate feedback in class settings using ICT has hardly been carried out. This is because the system load is significant, and moreover, it is impractical for the teacher to offer feedback to all students during a class.

Recently, the number of classes using ICT equipment has increased due to the advances made in ICT equipment. The same is true for receiving feedback from others. There are many studies on feedback in terms of different learning strategies. In particular, in recent years, there many studies have been conducted on providing feedback using ICT equipment (e.g., Oura et al. 2008). Due to the recent advancements in ICT equipment, educational facilities have begun to prepare environments that utilize these equipment during classes. As the result, it seems that environments in which ideas are transmitted between learners in real time are becoming more common, while learners are also able to receive feedback during class as a result of these changes.

People often need nudges to help them make decisions that are difficult and rare, for which they do not get feedback, and which contain aspects they have trouble translating into terms that they can easily understand (Thaler and Sustein 2008, p. 74). Thaler and Sustein (2008) define a nudge as any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentive. That is to say, by incorporating the nudge in a class, it is possible to promote the learning of a learner who does not know what to do.

Nudge studies have been conducted in a variety of educational fields, and Damagaard and Nielsen (2018) have identified twelve categories of research and practice that use nudges: default, framing, peer-group manipulations, deadlines, goal setting, reminders, informational, assistance, boosting skills to alleviate self-control problems, social comparison, extrinsic motivation, and social belonging identity activation and mindset. Among them, deadlines, goal setting, and reminders are necessary for development of SRL, as external factors intervene and induce behavior. In addition, it is possible for the learner to make active selection action by receiving information and assistance from another person. Based on these facts, in order to promote active action selection and SRL, this study incorporates a nudge system.

2 Purpose

By focusing on note-taking in the context of a secondary education mathematics course, this study aims to develop a system that can create a cyclical SRL process during class. This system visualizes how and when other learners are learning based on information regarding other learners' note-taking using tablet devices, which offers immediate feedback. By monitoring the learning strategies of others, one's own learning is also reviewed and reflected in terms of one's own learning strategies. By visualizing the learning strategy of others, we can thus promote learning between learners on the tablet, with the aim of developing a collaborative learning strategy.

This paper introduces the interface of the system and presents the policy of future evaluation. First, we introduce both the functions implemented in the Nudge System and the tools displayed on the screen. We then explain how to visualize learning on the tablet devices and for nudge learners, while also introducing how a learner's learning processes are recorded in the system. As a guideline for the analysis, we will conduct the analysis from three viewpoints designed to measure the usefulness of the system.

Furthermore, the interface evaluation of the system is evaluated based on how useful it is.

The study was conducted on a class in which each student had a tablet device in a wireless LAN environment. In the class, the material (PDF) was distributed to the tablet device of each user, with the material working as a notebook. The material included PowerPoints and blackboard contents prepared by the teacher in advance. Using this approach, it is possible to shorten the length of the class. The learner writes, underlines, or notes the points explained by the teacher in the material.

3 System Overview

The system (Below: Nudge System) is a web application that can be accessed by up to 45 people at a time, excluding teachers. Nudge System is a system utilized during class.

On Nudge System, the learner directly writes on the material that has been distributed via the table device. Then, the system collects the information written by all the learners, enabling the learners to review their own learning strategies, and the visualization is carried out based on the information, thereby facilitating learning (see Fig. 2). The system encourages learners to learn from other learners during class and asks them to display their learning strategies in a notebook on their tablet device, thereby enabling metacognition, review of their learning strategies, and reflection on how to proceed with their learning in terms of putting strategies into action. During class, learners learn how and when to improve their learning through the use of their peers' nudging. It is also possible for teachers to ask questions where there are many gaps to fill in, which might expedite deeper learning.

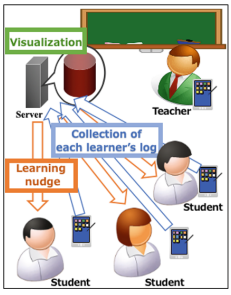

Fig. 2. How Nudge work

The key information here is not the content that the student wrote on the tablet, but the information showing the place and timing of their writing. This timing records the points at which other learners are writing in color, at these are then successively updated.

A key feature of the system is its division into four components: note-taking, collection of learning log, visualization of learning, and confirmation of learning log.

The details of each function and the reasons why we implement these functions are described below.

3.1 Note-Taking Function

The note-taking function enables learners to write, delete, and underline notes directly on materials distributed by hand on the tablet. This function can remove incorrectly written notes and underlining.

This function uses pens and markers as tools, and we will examine which has a stronger impact on learners when we analyze whether learners can make active decisions via Nudge System.

3.2 Collection of Learning Log Function

The collection of learning log function collects the contents that learners write and underline as notes in the learning log. The teacher can confirm the recorded learning log after the class. The collection learning log function records each time a learner writes on the lesson materials. Then, the system updates the records and reflects them as colors in the visualization of learning.

3.3 Visualization of Learning Function

The learning visualization function distributes materials related to the lesson (PDF) to the tablet device. When the learner takes notes or underlines on the same materials, the approximate parts of the materials written on other students' tablet devices can be visualized by color. The higher the number of entries in the same section, the darker the color. However, this function does not indicate specific contents for notes.

This function not only presents the learning strategy information of others to the learner, but also confirms what kind of learning behavior the learner's actions are an example of, based on the visualized information. This confirms whether or not there was decision making and behavioral change as a result of the nudge, as well as whether the learner engages in SRL during class.

3.4 Confirmation of Learning Function

The confirmation of learning function can check the learning log of each learner by specifying the date and time, teaching materials, and the users. This function is not available to learners, and only the teacher can check the process from the first notes to latest notes of all students after class. This function enables us to examine the long-term changes in the note taking of each learner, as well as to check whether the system affected the note-taking process.

4 System Interface

The interface of the system can be seen in Fig. 3. The upper toolbar consists of the Delete button, Select button, Marker button, Pen button, Swipe button, Shrink button, Zoom button, Page Select button (Show All Pages Drop-down), Next Page button, and Previous Page button.

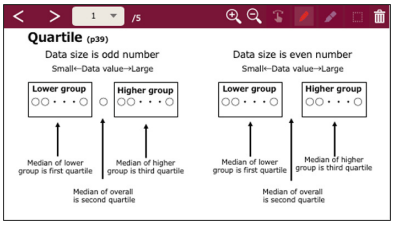

Fig. 3. System interface

The following is an explanation of how the visualization is carried out when Learner 1 and Learner 2 listen to the class and respectively write on the distributed lesson material. We also present a learner's screen, which changes over time (see Fig. 4):

1. Each learner takes notes and underlines during class to promote their own understanding and memory.
2. The system adds the thickness of the line written by the learner, the thickness of the marker, and the thickness of the set value set beforehand by the instructor. Then, a PNG image in which a line thicker than the line actually written by the learner is created. This PNG image is called a visualization layer. The visualization of the learning is feasible by superimposing the visualization layer on the lesson material.
3. When combined with the visualization layers created at the same time by others, the areas with more writing are highlighted. The visualization layer updates at regular intervals, providing information on how and at what time other learners are writing.

The thickness of the note, the thickness and color of the marker, and the transparency and color of the visualization layer can be changed by setting them before the class. The set value added to the memo is set so that other learners cannot judge the contents of the memo.

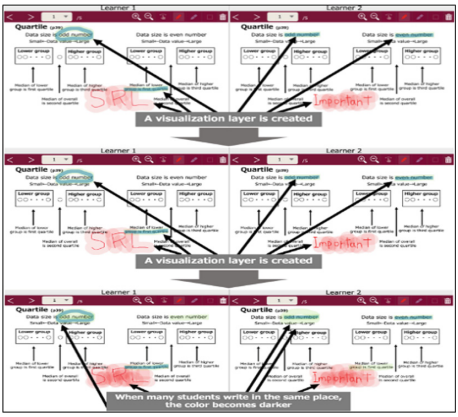

Fig. 4. Learner's screen, which changes over time

5 Evaluation Guideline

The practice using Nudge System is scheduled for June to July, 2020. Therefore, this paper introduces the viewpoints through which we will evaluate the interface of the system, and we will announce the results in an announcement on the day.

We will evaluate the system from three viewpoints. First, we will evaluate whether the cyclical process of SRL changes as a result of utilizing this system during class. This is possible because we will be able to see how many times learners try to improve their learning during class. The second viewpoint is the transformation of note-taking. In terms of whether the cyclical process of SRL shifts during class, we will observe potential modifications in the note-taking process during class. We will also observe and evaluate the quantitative and qualitative modification of note taking in long term. The third viewpoint is to conduct a questionnaire survey on whether there was a change in learners' own behavior and decision making by receiving a nudge from others during class. This will be done by assessing if learners used the Nudge System to assess whether nudges from others influenced their own thoughts and decisions.

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