Evaluation of a Sequential Feedback System to Promote Nudge Among Learners and Support Learning Strategies

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Abstract

Note-taking is an effective learning strategy for SRL development. However, due to the lack of opportunities to learn note-taking, learners cannot write complete notes. Therefore, from the perspective of co-regulated learning (Co-RL), we proposed that learners learn note-taking from each other. This study aimed to evaluate NoTAS, a note-taking support system using tablet devices. We asked 33 participants in the experiment to evaluate whether NoTAS promotes Co-RL and note-taking. The questionnaire results showed that the learners using NoTAS can learn and take notes through interaction with others. However, there were some cases where NoTAS prevented learners from note-taking, suggesting the need for improvement.

Keywords: Note-taking, Co-RL, Nudge theory, CSCL, Learning visualization

1. Introduction

1.1. Self-Regulated Learning

OECD (2018) indicated that learners need to develop self-regulated learning (SRL) competencies in the Learning Compass, a vision for the future of education. SRL is the ability to cycle through forethought, performance, and reflection on their own to learn effectively (Usher and Schunk, 2018). In the field of educational technology, much of the research on SRL development has focused on outside class learning support, such as encouraging reflection and learning management using assignments, portfolios, and learning management systems. However, outside class learning support can be burdensome in terms of preparations by teachers and activities by learners. On the other hand, Nilson (2013) proposed note-taking as one of the effective learning strategies for SRL development for in-class learning support.

1.2. Note-Taking and Support Methods

Note-taking has two types of features: encoding and storage functions (DiVesta and Gray, 1972). The encoding function facilitates recognition processing by combining the learning contents with the learner's prior knowledge through writing notes. The storage function enables effective review by reading notes. Morehead et al. (2019) suggest that many learners take notes in class but cannot write complete notes because they have few opportunities to learn note-taking strategies. One of the ways to support note-taking is to distribute class material. Class material clarifies the main points of the lesson (Kiewra, 1989). Furthermore, writing directly on the class material facilitates understanding of the class (Avval et al., 2013). However, only a few learners take organized notes on the teacher's explanations. Therefore, Lannoe and Miller (2019) suggest that more support is needed to encourage more learners to take notes.

Another practical support strategy is to provide feedback on note-taking. For example, Beaudoin and Winne (2009) developed the "nStudy system," which allows teachers and other learners to provide comments and detailed feedback on learners' essays. While "nStudy" can provide detailed feedback, it is difficult for instructors to provide note-taking instruction constantly, and we do not have enough time to share and discuss notes in the class (Nilson, 2013).

1.3. Who Provides Feedback on Note-Taking?

Hadwin et al. (2017) proposed Co-Regulated Learning (Co-RL) as a recent trend in research on regulated learning. Co-RL is a learning to regulate one's learning through interaction with others. Therefore, we suggest that note-taking feedback among learners is possible by applying the Co-RL theory.

In Japan, the Ministry of Education, Culture, Sports, Science, and Technology (MEXT, 2020) has promoted a policy to allow all learners to own devices to develop networks. Thus, many countries witnessed the growing trend of teachers and learners using Information Technology (IT) in classes in recent years. An example of such a feedback system is the "Metaboard," a learning analytics dashboard that supports learners' metacognition and SRL by visualizing their learning behavior (Chen et al., 2020). Furthermore, learners can take notes using a pen and tablet in class without any stress (Özçakmak and Sarigöz, 2019). Therefore, learners can use tablets for longhand note-taking instead of paper and keyboard. However, there is little study on supporting longhand note-taking with tablet devices applying Co-RL theory.

We hypothesize that learners who cannot take notes would be aided by assuming that the notes that many learners were taking were correct and providing them with feedback using tablets. Thus, to promote interaction among learners, we focus on "Nudge theory," which has been studied extensively in the field of behavioral economics in recent years (e.g., Thaler and Sunstein, 2009).

1.4. Nudge Theory in Education

Thaler and Sunstein define the nudge as any element of choice behavior that changes people's behavior predictably without narrowing the choice or significantly changing the economic stimulus (Thaler and Sunstein, 2009). Research on nudge has also been applied to educational studies (Weijers et al., 2020). However, most research is confined to nudging on teaching policies, with little research on nudging the learning strategies among learners in class. Here, we define the educational nudge as improving one's note-taking by referring to the colors and positions of others' note-taking. In this research, we aim to learn each others' learning strategies, such as note-taking in the class.

2. Purpose

In this study, we evaluated NoTAS developed by Kondo et al. (2021) that uses nudge to provide feedback on note-taking among learners in class. We applied NoTAS to subjects and evaluated its effectiveness by using questionnaires. There are two perspectives for the evaluation.
1. NoTAS promotes interaction with other learners (Co-RL) in the class.
2. NoTAS promotes note-taking based on the others' note-taking.

3. Methods

3.1. System Overview

Nudge for Note Taking Assist System (NoTAS) is a note-taking feedback system that can be accessed by up to 45 people at a time, excluding teachers (Kondo et al., 2021). NoTAS is available on web browsers such as Safari and Google Chrome. NoTAS has three functions: note-taking function, learning log function, and visualization function. Learners can use the note-taking function to write notes and highlights text directly on class material displayed on their tablet using their tablet pen. Two types of markers are available for learners to highlight the important parts and the unclear parts. The learning log function has two types: log collection and log confirmation. The log collection allows learners to save their note-taking sequentially as they write and erase notes and highlights in class material. Teachers can view the log of the learners' note-taking processes by specifying the learner (User ID) and the material (Class ID) using the log confirmation. Furthermore, the learning log function uses BASIC authentication so that only certain learners and teachers can access the system. The visualization function is the main of NoTAS. When a learner writes notes and highlights on the class material with visualization function, the approximate location of the notes and highlights written by others on the class material is visualized on the same material in almost real-time.

The interface of NoTAS consists of four layers: note-taking layer, learning log layer, learning visualization layer, and class material layer. On NoTAS, the learner directly writes on

the material that has been distributed via the tablet device. The note-taking layer and learning log layer correspond to the note-taking function. Then, to improve note-taking among learners, NoTAS collects and visualizes information, such as the place and time of writing of all learners, which facilitates learning. The learning visualization layer shows the position and timing of other learners' note-taking. Since this layer overlaps with the number of learners in class, the more learners fill in the same part, the darker the color becomes. As a result, the areas written by more learners are emphasized. Figure1 shows an example of the visualization function of NoTAS. Each color has the following meanings.

- The red areas mean that other learners wrote notes.
- The yellow areas mean that other learners highlighted important parts.
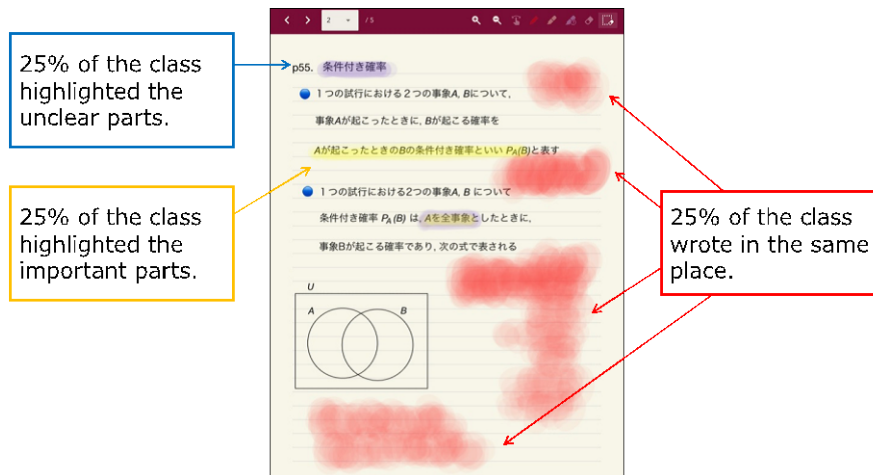- The blue areas mean that other learners highlighted unclear parts.

Figure 1. Visualization interface

3.2. Procedure of Research

We recruited university students to evaluate the NoTAS. The participants in this research were 33 students (males: 22, females: 11). The average age of the participants was 22.7 years old. We distributed a tablet (iPad 6th) and a tablet pen to the participants. Before the class, the participants had an opportunity to practice the operation of NoTAS. The experimental group ($n =$ 15) took the class using the visualization function of NoTAS. On the other hand, the control group ($n = 18$) took the class without using the visualization function of NoTAS. The class content was four instructional design theories, and the participants watched the class video using a projector. Figure 2 shows the procedure of research.

In addition to the participants, five collaborators wrote the contents set by the first author on the class material at a set time. This operation was conducted to verify the effect of the visualization function. We asked the participants on the face sheet, "If they had ever taken a class using a tablet and tablet pen," and found no significant difference between the two groups, $\chi^2(1)$ = 0.02, $p = .88$, $\phi = .03$.
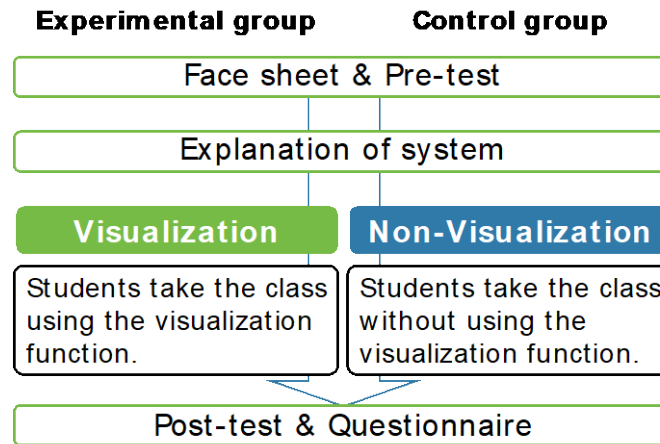
Figure 2. Procedure of research

3.3. Questionnaire

In this research, we surveyed questionnaires from three perspectives as follows:

Community Awareness

We quoted 15 items related to community awareness for Classroom Community Scale (Rovai, 2002). We have partially rewritten the text to be more consistent with the purpose of this study. Moreover, we created and added 3 original items about others' note-taking. We asked all items using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Social Presence

We adopted 3 items proposed by Short et al. (1976) to measure social presence: sociable – unsociable, personal – impersonal, and warm – cold. It employed a semantic differential method with a bipolar 7-point scale.

Note-taking Factor

We created 6 items related to whether learners referred to the others' writing in their note-taking. Moreover, we only asked the visual group 3 items regarding their feeling about using the visualization function of NoTAS. All items used a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

3.4. Guidelines for Analysis

We compared the results of the two groups' community awareness and social presence to investigate purpose 1, "Does NoTAS promote interaction with others?" We used these items as a measure to evaluate the promotion of Co-RL.

We compared the note-taking factor between the two groups to investigate purpose 2, "Does NoTAS promote note-taking based on the others' note-taking?" Moreover, we focused on

the visualization group results and compared them with the median of 3.00. The note-taking factor was used as an index to evaluate the nudge.

4. Results

In total, 33 participants answered the three questionnaires. The result of the questionnaires to evaluate Community Awareness, Social Presence", and Note-taking Factors in the class are presented below.

4.1. Community Awareness

Table 1 shows the results of Mann-Whitney U test for the scores of community awareness. The index was reliable (Cronbach's ± = .88). The class in which learners used the visualization function of NoTAS is called "Visual," while the class in which learners did not use it is called "Non-visual." Twelve items found significant difference and marginally significant, visual was higher in all items. However, there were ceiling effects and floor effects except for No. 7. Therefore, the learners felt that they were receiving real-time feedback on their note-taking by using NoTAS.

Table 1. Comparison of community awareness

	Visual		Non-visual		M_1-M_2	U		r
	M_1	SD_1	M_2	SD_2				
1. I felt that learners in this class cared about each other.	2.60	1.35	1.89	1.28	0.71	90.50	†	0.33
2. I felt that I was encouraged to ask questions.	2.53	1.19	2.22	1.00	0.31	114.00		0.16
3. I felt uneasy exposing gaps in my understanding.	3.93	1.49	3.50	1.43	0.43	112.00		0.17
4. I felt connected to others in this class. (R)	4.00	1.13	1.11	0.32	2.89	2.00	***	0.99
5. I did not feel a spirit of community. (R)	3.53	1.36	1.61	0.78	1.92	34.00	***	0.75
6. I felt that this class resulted in only modest learning because of using NoTAS. (R)	3.73	1.34	3.11	1.37	0.62	99.50		0.26
7. I felt that I received timely feedback on my notes and highlights in this class.	3.53	1.13	2.00	0.84	1.53	41.50	***	0.69
8. I trusted others in this class.	2.93	1.49	2.67	1.14	0.26	122.50		0.09
9. I felt isolated in this class. (R)	4.27	1.10	2.94	1.16	1.33	56.00	**	0.59
10. I felt that I could rely on others in this class.	3.33	1.29	1.44	0.71	1.89	34.00	***	0.75
11. I felt that other learners did not help me learn in this class. (R)	4.13	0.92	2.72	1.23	1.41	49.50	**	0.63
12. I felt that members of this class depended on me.	1.60	0.74	1.22	0.55	0.38	95.00	†	0.30

No.	Item	M_1	SD_1	M_2	SD_2	M_1-M_2			r
13.	I could feel how the other learners were listening to the teacher's explanation in this class.	4.20	1.27	2.50	1.30	1.70	46.00	***	0.66
14.	I felt uncertain about others in this class. (R)	3.53	1.25	2.78	1.40	0.75	94.00		0.30
15.	I found that the other learners were taking notes very hard.	4.53	0.64	3.67	1.03	0.86	68.50	*	0.49
16.	I felt confident that others would support me.	3.00	1.20	1.61	0.85	1.39	49.50	***	0.63
17.	I felt that I had enough opportunity to learn how to take notes in this class.	3.27	1.39	3.06	1.16	0.21	118.00		0.13
18.	I was curious about others' note-taking behavior.	4.00	1.46	2.83	1.43	1.17	61.50	**	0.54

Visual: $n = 15$, Non-visual: $n = 18$ $^\dagger p <.100$, $^* p < .050$, $^{**} p < .010$, $^{***} p < .001$
(R): Reverse score, 5-point Likert scale

4.2. Social Presence

The social presence score was the average value of the three social presence items. The result of Shapiro-Wilk test showed that this score was normally distributed. Moreover, the result of Levene's test showed that this score was equality of variance. Table 2 shows the results of Student's t-test for the social presence score. The index was reliable (Cronbach's $\pm$ = .88).

Table 2. Comparison of social presence

	Visual		Non-Visal		M_1-M_2	t		r
	M_1	SD_1	M_2	SD_2				
Social presence score	4.89	1.12	3.46	0.79	1.43	4.28	***	0.81

Visual: $n = 15$, Non-visual: $n = 18$, Semantic differential method $^{***} p < .001$

As a result, the visual's score was significantly higher than the non-visual' score. Therefore, learners can feel a higher social presence of others by using visualization of NoTAS.

4.3. Note-taking Factor

We compared the six note-taking factors (No. 1 to 6) between the visual and non-visual groups. All items were significantly higher in the visual group. However, we found a floor effect for all items in the non-visual group for the note-taking factor. We expected this result because the learners who did not use the visualization function of NoTAS could not watch the others' note-taking.

Then, we compared the values for the visual group with a median of 3.00. Table 3 shows the results of One-Sample Signed Rank Test for the value of note-taking factors. The index was reliable (Cronbach's $\pm$ = .83). We asked only the visual group about No. 7 to 9.

Table 3. Note-taking factors

	M	SD	M-3.00	W		r
1. I wrote the "teacher's writing" based on the notes and highlights of other learners.	3.47	1.51	0.47	71.00		0.18
2. I wrote the " teacher's oral explanation" based on the notes and highlights of other learners.	2.80	1.47	-0.20	39.50		0.34
3. I highlighted "the important points" based on the notes and highlights of other learners.	3.33	1.45	0.33	58.00		0.03
4. I highlighted "the points I did not understand" based on the notes and highlights of other learners.	2.40	1.06	-0.60	6.00	†	0.90
5. I wrote "symbols" based on the notes and highlights of other learners.	2.80	1.42	-0.20	26.00		0.57
6. I wrote in "diagrams and tables" based on the notes and highlights of other learners.	2.67	1.35	-0.33	26.00		0.57
7. The visualization prevented me from writing my notes. (R)	2.13	1.13	-0.87	17.00	**	0.72
8. The visualization prevented me from writing my highlights. (R)	2.87	1.60	-0.13	57.00		0.05
9. I enjoyed note-taking with the visualization function of NoTAS.	3.07	1.62	0.07	50.50		0.16

$n = 15$, (R): Reverse score, 5-point Likert scale $\quad\quad\quad^{†}p <.100, {}^{**}p < .010$

As a result, learners tended not to refer to others' highlights when they highligted parts they did not understand, $W = 6.00$, $p < .100$, $r = 0.90$. Furthermore, the visualization of NoTAS interfered with the learners' note-taking, $W = 17.00$, $p < .010$, $r = 0.72$.

5. Discussion

5.1. NoTAS Promotes Interaction Among Others

The results of community awareness suggest that the learners felt the interaction with other learners by using the visualization function of NoTAS. For example, they felt connected to others and felt that other learners helped them learn and note-taking. Furthermore, the learners felt that they were receiving sequential feedback on their note-taking using the visualization function. On the other hand, learners did not feel that they had enough opportunities to learn note-taking even though they used the visualization function of NoTAS. We suppose that this is because this study was a short-term experiment. This result suggests that learners learn more about note-taking by using the visualization function of NoTAS in the long term.

The social presence score suggests that the visualization function of NoTAS makes learners feel more social presence. Moreover, the visualization function helps learners recognize others' presence and promotes interaction among learners.

Therefore, we found that NoTAS promote Co-RL.

5.2. NoTAS Promotes Note-taking Based on the Others' Note-taking

From the results of the note-taking factor, we found that learners who used the visualization function wrote their notes based on others' writing more than the others who did not use this function. The visualization function of NoTAS automatically shares with learners the color and location information of others' notes and highlights. These results suggest that learners write notes and highlights using this visual information.

However, the mean scores of the visualization group were below 3.00 for many items. These results suggest that the visualization feature of NoTAS did not contribute much to the learners' note-taking. Furthermore, we found that the visualization might interfere with note-taking. There are two possible reasons as follow:

❿ The learners are not familiar with NoTAS
❿ The density of the visualization layer is set too high

As a future task, we need to have learners use NoTAS for a long time and evaluate their note-taking. Furthermore, the density of the visualization needs to be reduced.

References

Avval, F. Z., Jarahi, L., Ghazvini,K. and Youssefi, M. (2013) Distribution of Handouts in Undergraduate Class to Create More Effective Educational Environment. International Journal of Education and Research, 1(12)：1-6

Beaudoin, L. P. and Winne, P. H. (2009) nStudy: An Internet Tool to Support Learning, Collaboration and Researching Learning Strategies, Canadian e-Learning Conference held in Vancouver, Canada.

Chen, L., Lu, M., Goda, Y., Shimada, A., & Yamada, M. (2020). Factors of the use of learning analytics dashboard that affect metacognition. In Proceedings of 17th International Conference Cognition and Exploratory Learning in Digital Age, pp. 295-302

Di Vesta, F. J. and Gray, G. S. (1972) Listening and note taking. Journal of Educational Psychology, 63(1), 8-14

Hadwin, A., Jarvela, S. and Miller, M. (2017) Self-Regulation, Co-Regulation, and Shared Regulation in Collaborative Learning Environments, Schunk, D.H. & Greene, J. A. (eds), Handbook of self-regulation of learning and performance, pp.83-106

Kiewra, K. A. (1989) A Review of Note-Taking: The Encoding-Storage Paradigm and Beyond, Education Psychology Review, 1(2)：147-172.

Kondo, T., Yokoyama, K., Misono, T., Inaba, R., & Watanabe, Y. (2021). Effectiveness of an Interface That Facilitates Nudge to Improve Note-Taking Strategies. International Conference for Media in Education 2021 Conference Program and Proceedings, 165-166

Lannone, P., Miller, D. (2019) Guided notes for university mathematics and their impact on students' note-taking behaviour. Educational Studies Mathematics, 101：387-404

Ministry of Education, Culture, Sports, Science, and Technology (2020) Realizing the GIGA School concept. https://www.mext.go.jp/a_menu/other/index_00001.htm (accessed by 2021.10.20) (In Japanese)

Morehead, K., Dunlosky, J., Rawson, K. A., Blasiman, R., & Hollis, R. B. (2019) Note-taking habits of 21st century college students: implications for student learning, memory, and achievement. Memory, 27(6)：807-819

Nilson, L. B. (2013) Creating self-regulated learners, Virginia, Stylus publishing.

OECD (2018) OECD Learning Compass 2030. http://www.oecd.org/education/2030-project /teaching-and-learning/learning/learning-compass2030/OECD_LEARNING_COMPASS _2030_Concept_note_Japanese.pdf (in Japanese)

Özcakmak, H. and Sarigöz, O. (2019) Evaluation of Turkish teacher candidates' perception of note taking concept, Educational Research and Reviews,14：78-86

Rovai, A. P. (2002). Development of an instrument to measure classroom community. Internet and Higher Education, 5(3), 197–211

Short, J., Williams, E., & Christie, B. (1976). The social psychology of telecommunications. Toronto; London; New York: Wiley.

Thaler, R. H, and Sunstein, C. R. (2009) Nudge: Improving Decisions about Health, UK, Wealth, and Happiness.

Usher, E. L. and Schunk, D. H. (2018) Social Cognitive Theoretical Perspective of Self-Regulation, In B.J.Zimmerman and D.H.Schunk (Eds.) Handbook of Self-Regulation of Learning and Performance, New York: Taylor & Francis Group：19-35

Weijers, R. J., de Koning, B. B., & Paas, F. (2020). Nudging in education: From theory towards guidelines for successful implementation. European Journal of Psychology of Education.