Impact of Visualizing Others' Note-Taking Situations on Note Revision and Review

Kondo, T., ISHII, K., Misono, T., Inaba, R., & Watanabe, Y.

Revising notes is important, but more research is needed to support this. In this study, we evaluated what learners refer to when revising their notes after class and the impact of visualizing other learners' note-taking of the revision. The experiment results showed that the participants were revising their notes based on their memories of class and texts on the materials. Furthermore, the visualizations also supported note revision, and it was suggested that the visualizations of notes, important highlights, and unclear highlights each influenced different types of descriptions, such as symbols, highlights, elaboration and organization.

Introduction

Note-taking is one of the most used learning strategies among students. Students take notes during class and review their notes afterward to prepare for tests. However, recent research such as Luo et al. (2016) introduced the concept of "note revision," where additional information is added to notes taken during class (encoding). They proposed three note-taking processes: encoding, revision, and storage.

Morehead et al. (2019) pointed out that students often lack opportunities for formal training in note-taking, which limits their ability to create high-quality notes. One method to support improved note quality is to provide students with class materials. Adding annotations on distributed class materials helps students identify key points in the lesson and encourages summarization (Avval et al., 2013). However, Lannone and Miller (2019) argued that more than simply distributing class materials is required for taking complete notes.

The note revision process is crucial for recording additional information in notes (Luo et al., 2016). Their study demonstrated that incorporating short pauses during class for students to revise their notes with peers increased the amount of content recorded and improved academic performance. Furthermore, Flanigan et al. (2023) suggested the effectiveness of long-hand note revision. While the benefits of note revision have been recognized, effective strategies for facilitating note revision still need to be explored.

Kondo et al. (2023) have developed a tablet-based note-taking support web application called NoTAS (See Figure 1). NoTAS enables the collection of note-taking logs, recording when and what content is added or deleted from class materials. Using these logs, NoTAS can visualize classmates' note-taking on each learner's material in real time. Three types of annotations can be visualized: notes, important highlights, and unclear highlights. Additionally, the visualization becomes darker in areas where more learners have made annotations. While NoTAS enhances community and note-taking during class, its impact on post-class note revision and review remains to be seen.

Purpose

This study aimed to examine the impact of visualizing others' note-taking using NoTAS on note revision and review. Thus, we added a new feature to NoTAS and conducted an experiment based on the following two research questions:

1. What elements do participants refer to during note revision?
2. What kind of descriptions were added during note revision as influenced by the visualization function of NoTAS?

Figure 1

The Visualization Function of NoTAS (Created based on Kondo et al., 2023)
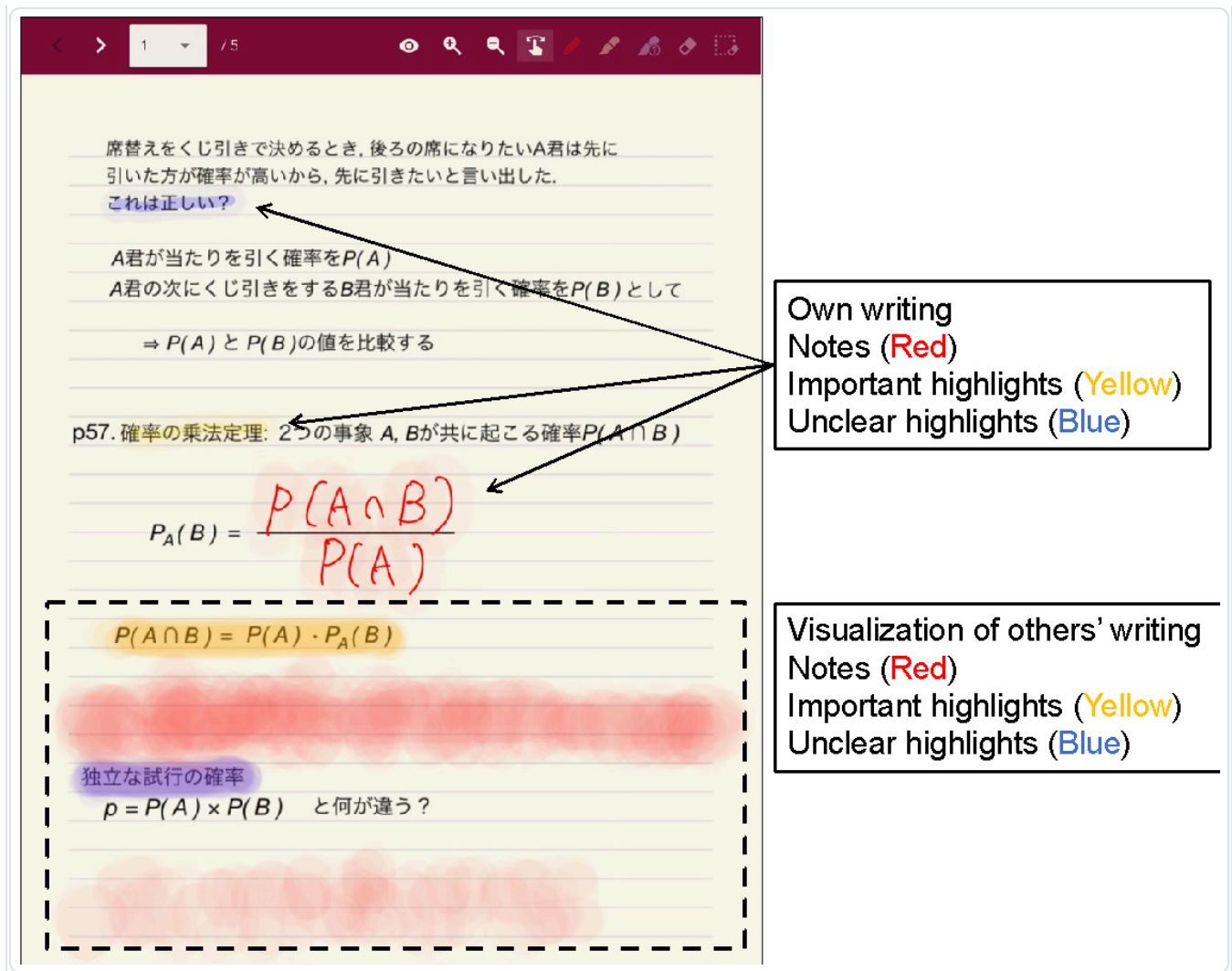
Methods

Visualization Switching Feature

The real-time note-taking visualization of NoTAS was effective during class because a class progresses according to the teacher's direction. In contrast, the pace of note revision and review varies among learners after class. Therefore, we added a visualization-switching feature that allows learners to toggle between different visualization modes in NoTAS after class. Learners can select two types of visualization: "in-class" and "after-class." The In-class visualization displays only the notes and highlights made by classmates during class. The teacher sets the class end time in advance so that NoTAS can visualize the logs saved up to that point. On the other hand, the after-class visualization shows all annotations made both during and after class. Therefore, when learners revise their notes after class, they can easily identify areas where others have made revisions by switching between "in-class" and "after-class" views (See Figure 2).

Figure 2

In-Class and After-Class Visualization Modes
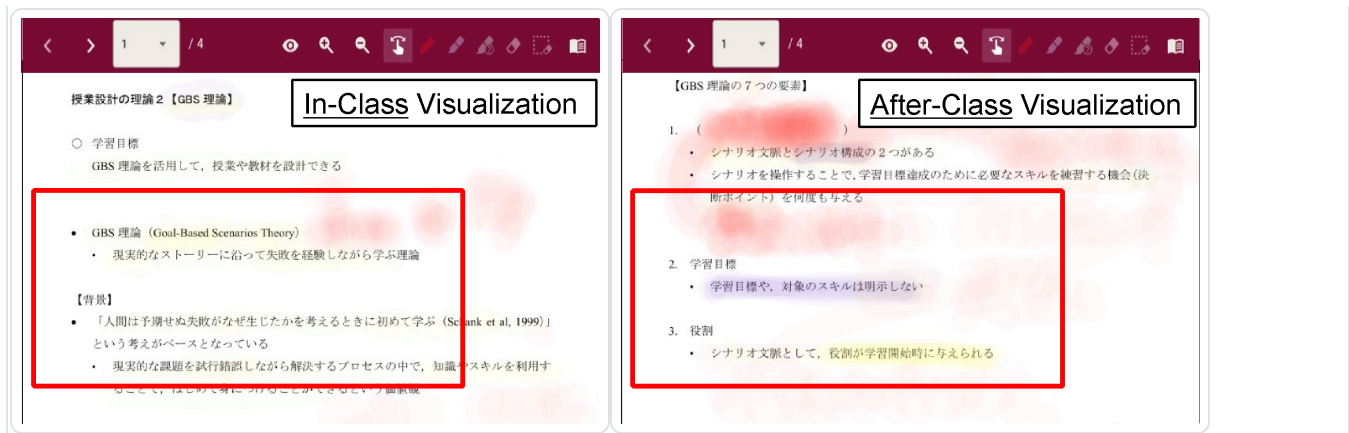
Procedure

We recruited undergraduate and graduate students from a university in Japan to participate in the experiment. We selected 21 participants among the applicants who had never used NoTAS before. The experiment was conducted in October 2023.

First, participants were given an overview of the experiment and signed an informed consent form. Next, they practiced using NoTAS with the provided iPad 6th and a tablet pen. Following this, they took a 30-minute class on three theories of instructional design using NoTAS. After the class, they spent 15 minutes revising and reviewing their notes in preparation for the test using NoTAS. During the period, our collaborators intervened by adding notes and highlights in specific sections to increase the opacity of visualizations where the teacher wanted participants to make annotations. Finally, participants completed a post-test. Within three days after the experiment, each participant responded to a questionnaire regarding their note revisions, and within one week, they participated in a follow-up interview based on the results.

Data collection

We reviewed the note-taking logs collected through NoTAS and created individualized questionnaires for each participant based on the annotations they added or deleted after class. We assigned a number to each description written during the note revision. To identify what each participant referenced during note revision, we asked multiple-choice questions for each annotation with the five opinions. We conducted the survey using PowerPoint, and participants responded by marking the applicable options in red for each entry. Figure 3 displays a sample response.

We further conducted interviews based on these results, asking participants to specify which visualized sections they referenced for each description categorized as "referenced the visualization." Additionally, for annotations categorized as "other," we also asked about the sources to which they referred.

Figure 3

How to Investigate Elements Referenced

Results

Elements referenced during note revision

During the note revision process, 297 descriptions were added, and four descriptions written in class were deleted. Table 1 shows the number and percentage of events referenced during note revision, based on the results of a questionnaire asking what participants referred to while revising their notes. The most frequently referenced element was "recalling the teacher's explanation in class," which accounted for 46.51% of all descriptions, nearly half of the references. Additionally, as the questionnaire allowed multiple-choice responses, many participants indicated that they revised their notes by referencing multiple elements. Finally, the primary reasons given for deleting descriptions written in class were "mistakenly written" and "understood during review."

Table 1

Elements referenced during note revision

Item	Number	%
1. Recalling the teacher's explanation in class	140	46.51
2. Referring to texts in the class materials	125	41.53
3. Referring to the visualized parts	69	22.92
4. Referring to own descriptions I wrote in class	54	17.94
5. Other	46	15.28

n = 21

Descriptions added based on the visualizations in note revision

Table 1 also shows that approximately 23% (69 descriptions) of the additions made during note revision referenced NoTAS visualizations. Table 2 presents the types of descriptions added by the 12 participants who referenced the visualizations, with counts provided for each type of visualization: notes, important, and unclear highlights. Furthermore, some participants referred to more than one type of visualization for a description, and the counts were calculated with overlaps.

Table 2
Types of descriptions added based on NoTAS visualizations

Type	Notes	Important highlights	Unclear highlights
1. Elaboration (paraphrasing and linking)	4	6	7
2. Organization (concept structuring)	0	5	4
3. Emphasis with symbols (marks and boxes)	4	6	5
4. Linking with symbols (arrows and boxes)	10	4	3
5. Highlighting important parts	6	11	7
6. Highlighting unclear parts	3	2	6
7. Total descriptions	27	34	32

n = 12

Discussion

RQ1: Elements referenced during note revision

Participants added 297 descriptions, such as notes and highlights, during note revision while removing four annotations written in class. The most frequently referenced event was "recalling the teacher's explanation in class," accounting for 46.51%. This high percentage may be due to the timing of the note revision and review, which took place immediately after class, making it easier for participants to recall class content. Furthermore, participants wrote more than 41% of the descriptions referring to "texts in the class materials." Avval et al. (2013) pointed out that class materials help learners focus on key points in a lesson. Thus, these results suggest that the class materials also facilitate the addition of information during note revision.

Among the descriptions added during note revision, 23% were based on the visualization of classmates' note-taking. Many participants also referenced a combination of the memory of class and class materials, indicating that NoTAS visualizations may serve as a promotion to use other sources.

Descriptions added based on participants' own previous descriptions were the least frequent, according to 18%. Luo et al. (2016) noted that learners often did not rewrite their fragmented notes written in class during note revision, as these partial notes help them recall class content. In this study, accurate information from the class materials and NoTAS visualizations might have provided more useful references than their own notes, which may explain the lower percentage of referenced own descriptions.

Some of the specific responses in the "other" included marking terms to memorize for exams and highlighting areas where participants felt their understanding was lacking.

RQ2: Description types from visualization in note revision

Twelve participants reported using NoTAS visualizations to guide their note revision. The visualization of others' notes, such as arrows and boxes, appeared to be useful for linking material content. The visualization of others' important highlights not only encouraged participants to add their own highlights to the same texts but also served as a reference for summarizing and organizing concepts from the content.

The visualization of others' unclear highlights helped participants to decide whether to highlight texts as either "important" or "unclear," depending on their own understanding. Furthermore, participants engaged in behaviors such as elaboration by adding concrete examples or descriptions and organization by structuring their notes with arrows, based on the visualized areas. Through these activities, participants reflected on and assessed their level of understanding during note revision.

Conclusion

This study aimed to examine the impact of visualizing others' note-taking using NoTAS on note revision and review. We introduced a visualization-switching feature and experimented. The questionnaire results indicated that participants primarily referred to their memory of the class and the materials when revising their notes. Furthermore, it was revealed that visualizations of classmates' note-taking partially facilitated additional annotations after class. Additionally, it was suggested that the visualizations of notes, important highlights, and unclear highlights each influenced different types of descriptions. However, since some participants could not effectively use NoTAS visualizations for note revision, further research is needed to verify its long-term effectiveness.

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.

Flanigan, A. E., Kiewra, K. A., Lu, J., & Dzhuraev, D. (2023). Computer versus longhand note taking: Influence of revision. *Instructional Science, 51*(2), 251-284.

Kondo, T., Misono, T., Inaba, R., & Watanabe, Y. (2023). Learning Visualization System to Improve the Community Sense and Learning Behavior in Class. *International Journal for Educational Media and Technology, 17*(1), 1-14.

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

Luo, L., Kiewra, K. A., & Samuelson, L. (2016). Revising lecture notes: How revision, pauses, and partners affect note taking and achievement. Instructional Science, 44, 45-67.

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.

Acknowledgments