An Analysis of the Note-Taking Function of the Audience Response System

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Abstract. This paper analyzes the note-taking function of the Audience Response System. The analysis shows the positive effects of the note-taking function and it shows that the note-taking function interacts with other ARS functions. Studying these features will help design more interactive lectures.

Keywords: Digital-note-taking · ARS · e-learning

1 Objective

Note taking using electronic instruments is gaining popularity. To improve interactions with their audiences, presenters use systems that record audience responses, such as the Audience Response System (ARS). The note-taking function of ARS is examined in this paper. ARS introduced by this paper is a module of Xoops, an open-source content management system (CMS). This paper has two objectives. First, it will introduce the features of the note-taking function. Second the effect of the note-taking function will be analyzed.

Note taking is one of the most common ways of learning. Therefore, the importance of note taking is often pointed out by educational technology research. Some researchers such as Nakayama et al. [6, 7] investigated the digital note-taking system, which is suitable for the network age. The system introduced by this paper seeks to reinforce ARS by using the note-taking system. ARS allows us to conduct interactive lectures in which the audiences use devices like clickers to respond to questions posed by the lecturer. In addition, ARS has also been developed as a web application that can be accessed using a mobile phone [3]. Iitaka [3] introduced one such application, which also has the note-taking function.

This paper focuses on the note-taking function of the ARS module. First, related literature is analyzed. Then, the note-taking function will be explored. After that, we analyze the data for which the ARS module was implemented. We obtained statistically significant results that enabled us to estimate the positive effect of the note- taking function.

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2 Background

We first analyzed similar studies from literature. Note taking has a positive effect on learning. Previous studies such as Weener [8] have described these positive effects. Digital note taking has also been investigated in the network age [6]. According to Nakayama et al. [7], the positive effect of digital note taking has been confirmed. Nakayama also predicted the possibility of sharing digital notes online.

This paper is based on these arguments. The note-taking function described in this paper is a function of the online e-learning system. The online e-learning system here is the ARS module of CMS.

The typical ARS is realized by using special instruments such as a clicker. When lecturers ask questions during lectures, the audiences can answer using such instruments. The ARS that does not depend on such special instruments has also been investigated. Web applications that are accessed by mobile phones can also be used for note taking. We developed an ARS that is a module of CMS, which is already being used in various universities. If we take advantage of such circumstances, we can use course data and student data to make the system more useable. Besides, the ARS module shares the question data with the online drill module introduced by Iitaka [1, 2]. Data sharing makes the ARS module more useful.

The ARS module introduced by Iitaka [3] also has a note-taking function. Like ARS, the note-taking function is often used during lectures. Therefore, we can expect further usability.

This note-taking function has already been introduced by Iitaka [4, 5], who tried to evaluate its applicability. However, it could not be fully determined because very few individuals in the audience chose to implement this notebook function. Therefore, a lecture had to be designed to encourage audiences to use the note-taking function.

3 Method

3.1 Features of Note-Taking Function

This section shows the structure of the note-taking function. Then, we will see how to use the function.

Figure 1 shows the possible applications of the note-taking function.

A major advantage of this ARS module is that it enables audiences to share and evaluate notebook data with other groups. The common evaluation of the notebook data promotes data sharing, which, in turn, encourages the audience to learn harder.

The ARS module allows us to set keywords that can be used to check the audiences' understanding of lectures. The system determines whether the keywords appear on the notes taken during the lectures. If keywords are present in the notebook data, we can assume that the audience has understood the lecture content (Fig. 2).

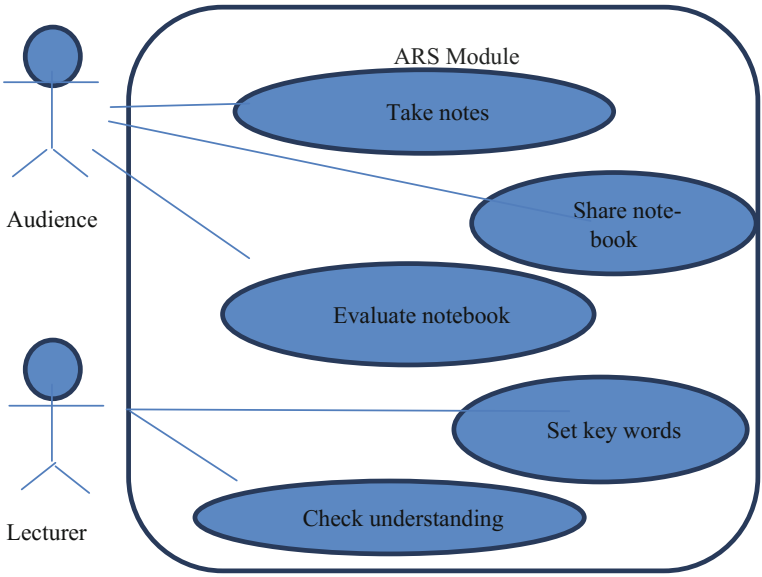

Fig. 1. Possible applications of the note-taking function

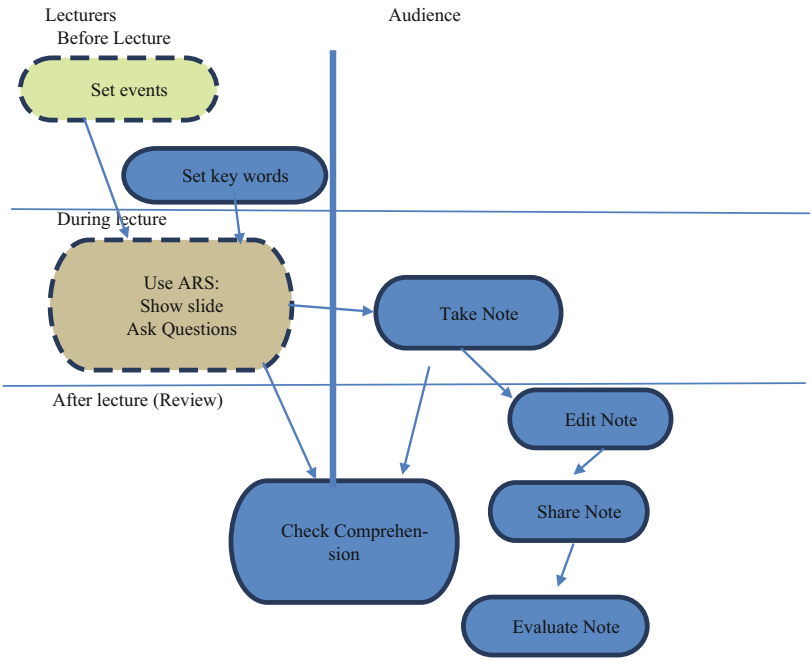

Fig. 2. How to use the note-taking function

Then, we show the data structure of the note-taking function (Fig. 3).

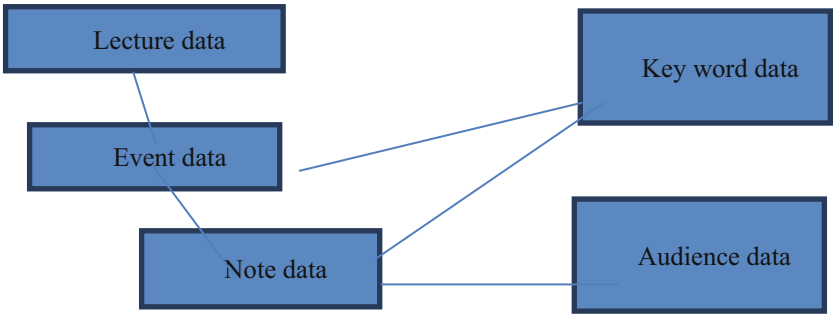

Fig. 3. Data structure of the note-taking function

Keyword data is a characteristic of the note-taking function; it corresponds to event data. An event such as a slide or a quiz, which is shown during a lecture, has multiple keywords. The notebook data of each user also corresponds to the event data. This structure allows us to check whether the keywords appear in the notebook data. Hence, we can check whether a user has understood the event about which notes were taken. This feature and the sharing of notebook data are two big advantages of digital note taking.

Subsequently, we provide some more concrete descriptions. First, we show how to set keywords.

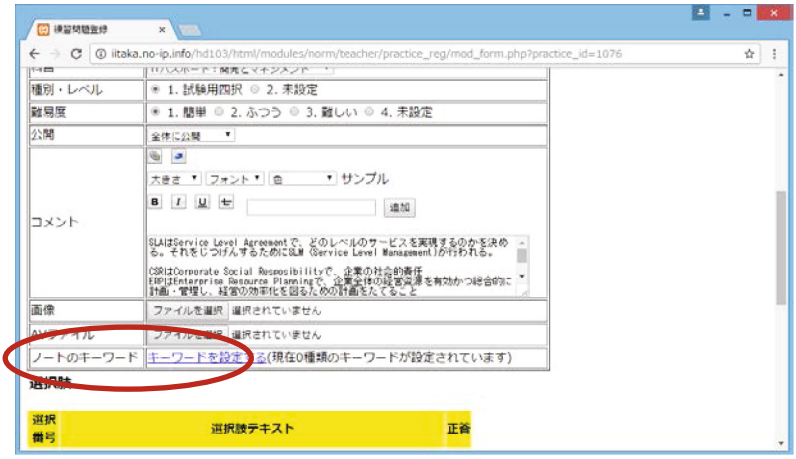

Fig. 4. Page for EventSetting

As shown in Fig. 4, each event that has been set has hyper texts that allow us to access the page for setting key words (Fig. 5).

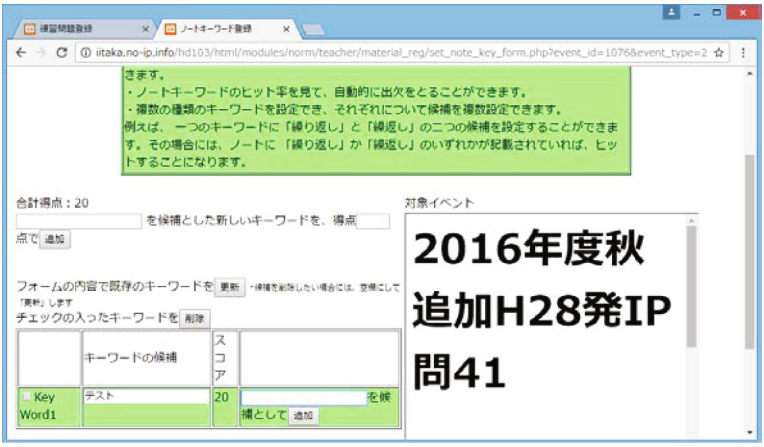

Fig. 5. Page for setting keywords

We can set multiple keywords for each event on this page. Besides, we can set the importance of each keyword. Notebook data with more important keywords can have a higher evaluation.

Audiences can access the following pages during the lectures (Fig. 6).

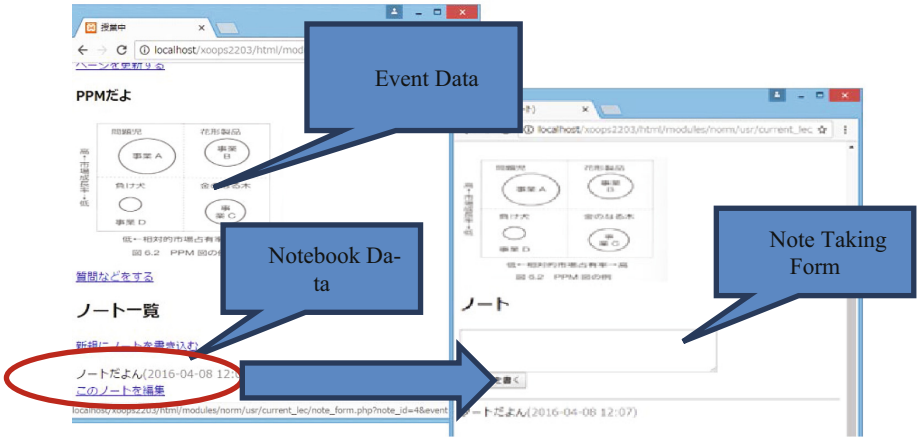

Fig. 6. ARS page for audience and page for note taking

This ARS answer form also has hyper texts that brings audiences to the page for note taking. This note-taking page allows us to write notes about events during lectures. Notebook data always relates to the event data of lectures. Therefore, by checking the notebook data, we can determine whether the listeners are concentrating on the lectures and understanding the contents. If keywords occur in a person's notebook data, we could conclude that he or she has understood the contents and is able to concentrate on the lectures.

Besides, we can use this ARS after lectures. Audiences can review events of the lectures using the following page (Fig. 7).

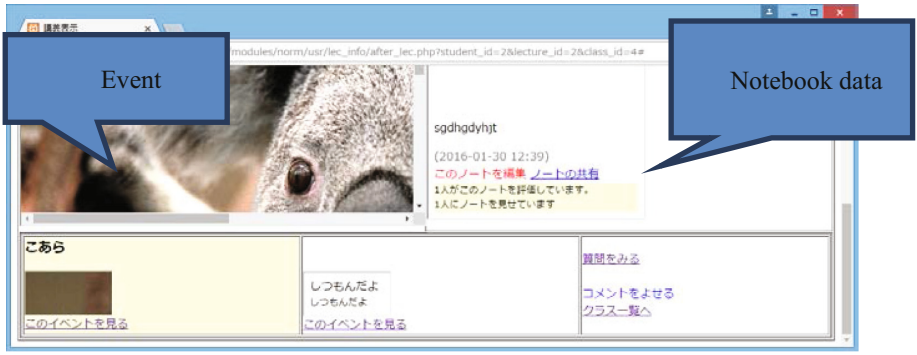

Fig. 7. Review page

The audiences can read the note on each event using this review page. This page also enables the audiences to edit the note. CKEditor is implemented to realize this function.

This system is designed to share the edited note data using the pages shown in Fig. 8.

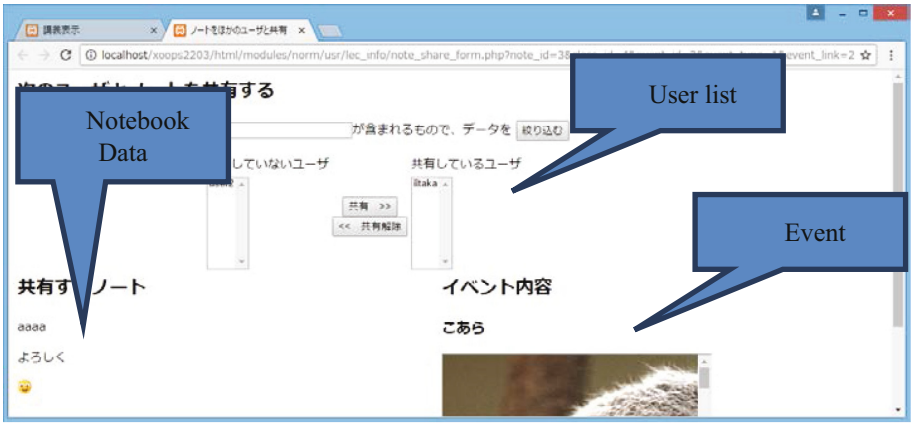

Fig. 8. SharedNotebookData

The review page displays not only the user's own notebook data but also the shared notebook data that is written by other users. The user who is allowed to access another person's notebook data can evaluate that data. This feature of the note-taking function can promote peer learning.

Besides, both lecturers and audiences can check how many keywords appear in the notebook data when they access the following page (Fig. 9).

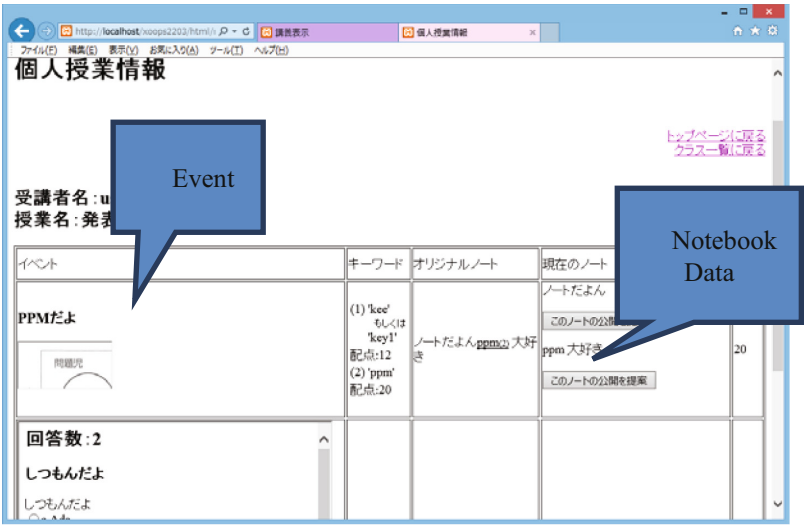

Fig. 9. Review notebook page

Using this page, we can check whether there are keywords in the notebook data, which will enable us to grasp the understanding of audiences. This feature will make our review of the lecture more effective. Besides, the lecturers can teach easily according to the audience's understanding.

3.2 Research Questions and Hypothesis

The effect of digital note taking has already been proven [7]. Therefore, the note-taking function of this paper must also have a positive effect. We phrase our research question (RQ) and hypothesis (H) as follows:

RQ1. Does the note-taking function have a positive effect on the examination score?
H1. The audience that used the note-taking function tends to obtain higher scores than the audience who did not use it.

If the note-taking function of this paper is correctly developed, the hypothesis H1 must be proven because Nakayama [7] has already shown the positive effects of note taking.

The note-taking function of this paper must have additional effects. It is intended to be more effective in combination with various other functions of the ARS module. Therefore, we phrase the second research question as follows:

RQ2. Does the note-taking function have a positive effect in combination with other functions of ARS?

We will verify the above research questions in the following section.

3.3 Use of the Note-Taking Function During Lectures

As shown in Sect. 2, the lecture needs to be designed to encourage audiences to use the notebook function. Therefore, we considered designing the study to attract new users. In particular, the use of the note-taking function was announced and recommended to the audiences at the beginning of the lecture.

ARS was implemented in the lecture as shown in Table 1.

Table 1. Lecture characteristics with ARS implemented

Lecture objective	Introduction to Informatics: Preparing for a qualifying examination on information technology
Type of audience	Students at the Faculty of Economics
Period	April–July 2016
Number of attendants	250
Number of note-taking function users	47

As shown in Table 1, the lecture was designed to help the audiences pass a qualifying examination on information technology. The lecturer explained some issues on information technology and provided related questions from past examinations. Then, the audiences answered the questions using cell phones and ARS. There were 250 attendants, and 47 of them (18%) used the note-taking function. In contrast, only 5% of the participants used the function in the lecture studied by Iitaka [5]. Therefore, this analysis can be considered more reliable than that of Iitaka [5].

Next, the effect of the note-taking function was examined based on the scores achieved by participants during the periodic examination of the lecture.

As shown in Table 2, both skewness and kurtosis are not extreme. Therefore, we consider the distribution of the score data as a normal distribution.

Table 2. Scores on the periodic examination

Average score of all participants	26.46
Average score of the function users	28.30
Average score of participants who did not use the function	26.03
Skewness	−0.427
Kurtosis	−0.466

Then, we checked RQ1. We analyzed the effect of the note-taking function. The average score of all the participants was 26.46. The average score of the function users was 28.30 points; the participants who did not use the function had an average score of 26.03 points. Therefore, the average score of the function users was higher than that of the participants who did not use the notebook function. The t-test proved that the difference is statistically significant ($t(248) = 2.005$, $p < 0.05$). Therefore, we can say that H1 is proven.

These results find support in literature [7]. This paper further studied the effect of the note-taking function in combination with other functions of ARS, which is RQ2. We examined the research question by interacting with other functions of ARS. When we examined the interactions, we found statistically significant interactions between the use of the note-taking function and the use of the comment function. The ARS module has many side functions. The comment function is one of them; it allows the audience to write comments during lectures. The comments are displayed on the screen along with the events (Fig. 10).

Fig. 10. Comments during lectures

To check the interaction, we divide the users of ARS into three groups based on the frequency of use of the note-taking function.

Table 3. User groups

	Frequency	Number
Group 1	0	198
Group 2	1–5	36
Group 3	6–	16

As shown in Table 3, the 198 users who never used the note-taking function formed Group 1; the 36 users who used the function 1–5 times formed Group 2; and the 16 users who used the function more than six times formed Group 3. Though comment writing itself did not have any effect on the examination score ($t(248) = 0.466$, n. s.), it could reinforce the effect of the note-taking function. We could confirm interactions between comment writing and note-taking. ANOVA proved that the interaction is statistically significant ($F(2, 244) = 3.08$, $p < 0.05$).

Table 4. Result of analysis of the interactions (1)

Comment writing		Mean	Std. Error	95% Confidence Interval	
				Lower bound	Upper bound
Not used	Group 1	26.364	.581	25.219	27.509
	Group 2	27.762	1.501	24.806	30.718
	Group 3	27.750	2.432	22.960	32.540
Users	Group 1	25.362	.903	23.583	27.141
	Group 2	24.667	1.776	21.169	28.165
	Group 3	34.750	2.432	29.960	39.540

Table 5. Result of analysis of the interactions (2)

Comment writing			Mean Difference (I − J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
						Lower bound	Upper bound
Group 1	Not used (I)	Users (J)	1.002	1.074	.352	−1.113	3.118
	Users (I)	Not used (J)	−1.002	1.074	.352	−3.118	1.113
Group 2	Not used (I)	Users (J)	3.095	2.325	.184	−1.485	7.675
	Users (I)	Not used (J)	−3.095	2.325	.184	−7.675	1.485
Group 3	Not used(I)	Users (J)	−7.000*	3.439	.043	−13.774	−.226
	Users (I)	Not used (J)	7.000*	3.439	.043	.226	13.774

*$p < 0.05$

[a]Adjustment for multiple comparisons: Bonferroni.

Tables 4 and 5 show the significant differences within Group 3. The users of the comment function of Group 3 obviously obtained higher scores than other members of Group 3. The average score of the users in Group 3 was 34.75, whereas the average score of other members in Group 3 was 27.75. Therefore, we obtained results that allowed us to estimate the interactions between the comment function and the note-taking function. These results show how to design a better lecture by using ARS.

4 Discussion of Results

This paper first described the features of the note-taking function. Then, the effect of the function was analyzed. Though the positive effect of note-taking itself had already been confirmed, the effect of the system developed in this paper had not been confirmed [5]. Iitaka [5] stated that this happened because not enough users used the note-taking function. Therefore, this paper tried to obtain more users. As a result, we can confirm statistically significant results that allow us to estimate the positive effect of the note-taking function on the examination scores.

Besides, we also confirmed the interactions between the note-taking function and other ARS functions. We can estimate that the note-taking function interacts with the

comment function. If this interaction is investigated more deeply, it will help us design more interactive lectures. We are now building the recommendation engine that suggests better learning plans based on various CMS data. This interaction may help us to create data for such recommendation engines.

However, even this study has a serious limitation. As a reviewer of this paper correctly pointed out, the number of users of the note-taking function is still not enough to perform an in-depth analysis. Actually, an important characteristic of the function is checking keywords and sharing note data. However, there were too few users who had used these sub-functions.

Therefore, we need to design lectures that motivate more audiences to use the note-taking function. Then, we will be able to analyze the effects of the sub-functions (e.g., checking keywords and sharing notes). This analysis will contribute to providing more effective lecture designs using ARS.

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