Anchored Feedback: Deictic Indicator Providing Cognitive Guidance in a Classroom Feedback System

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In this study, we proposed a method of feedback termed anchored feedback in a classroom feedback system and conducted two experiments for the evaluation. The system enables text-based communication between students and the instructor via arrow-shaped indicators, directing feedback to the target topic in the lecture slide on shared computer screens. In Experiment 1, we evaluated the deictic function by comparing an interface with the deictic feature to one without it, and the findings suggested that the deictic function facilitated access to feedback by directing it to the target topic. In contrast, in Experiment 2, we investigated the practicality of the feedback system in an actual lecture, and the results revealed that the system increased the participants’ consciousness of interactivity, with the exception of those participants who had keyboarding difficulties.

Key words: CSCL, Anchored Feedback, Classroom response system, Cognitive guidance, Cognitive load

1. INTRODUCTION

Lectures have long been one of the most effective and common methods of instruction in classrooms (Bligh 2000). However, lectures are not effective for instructors to monitor students’ current state of understanding and utilize it in the subsequent instruction, albeit such formative teaching has been emphasized in previous research (Black and Wiliam 1998, Cazden 2001). Another issue is that as the class size increases, students tend to become more hesitant to speak aloud due to their fear of embarrassment; it makes this issue even more problematic (Bligh 2000, Anderson et al. 2003).

In contrast, Bransford et al. (2000) suggested the potential for transforming large lecture classes using classroom technology. Classtalk (Dufresne et al. 1996), for example, provides the instructor with tools for presenting students with questions and gathering their responses through hand-held devices in order to recognize the students’ current level of understanding and to determine the subsequent instruction based on it.

In more recent years, i-room (Sato et al. 2002), AirTransNote (Miura et al. 2005), and Classroom Presenter (Schwarm et al. 2002, Anderson et al. 2006) have enabled more flexible communication, in which students’ express their thought in a variety of modes such as category, number, text, and drawing.

However, delivering lectures using such communication systems resulted in a potential issue of cognitive overload in that a large amount of student feedback imposes a heavier cognitive load on the instructor (Anderson et al. 2003, Sweller 2005, Feldon 2007). Instructors using such systems are likely to be exposed to a large amount of information, and therefore it becomes difficult for the instructor to recognize all the information and utilize it to determine the subsequent instruction within the limited time period of a lecture.

Moreover, students are also faced with the similar situation in which their attention can be distracted away from the essential part of lecture slides due to display of the extra information (Sato et al. 2002).

In order to solve this issue, in this study, we proposed a kind of feedback termed anchored feedback, aimed at facilitating feedback access in a classroom feedback system, and we conducted two experiments to evaluate the validity of the
suggested mode and practicality of a system with the anchored feature.

2. ANCHORED FEEDBACK SYSTEM

The Anchored Feedback System (AFS) is a classroom feedback system that enables students and their instructor to share lecture slides and send text-based feedback through their computers. AFS is available as a web-based application in a web browser with Adobe Flash Player installed in any OS such as Windows, Linux, or Mac. The system comprises two servers: a web server for the system gateway and a Macromedia Flash Communication Server for facilitating synchronous transactions among users.

The student interface of AFS consists of slide, edit, and display panes (see Figure 1), designed to facilitate the user (student) to view lecture slides at their own pace and to help them send text-based feedback to the instructor in the course of a lecture.

To send feedback, the user (1) selects one of the three arrow-shaped indicators (red: explanation, green: example, and blue: comment) (see Figure 1) at top of the slide pane; (2) drags it to the target topic in a slide; (3) edits the content of text in the edit pane; and (4) sends it by clicking on the send button. Subsequently, the indicator is immediately visible on computer screens of all the students. Further, they can grade the feedback using vote function, and the

![Fig. 1. Student Interface](image1)

![Fig. 2. Instructor Interface](image2)
total number of votes is displayed on the indicator.

In contrast, the instructor interface (Figure 2) consists of slide and navigation panes designed to facilitate the user (instructor) to direct feedback to the target topic in the lecture slide. Although there is no display pane as seen in the student interface, each feedback is displayed in a pop-up window by hovering the mouse cursor over the indicator in order to maximize width of the instructor screen as large as possible.

On the other hand, in the navigation pane, the user can overview slide thumbnails and the total number of the responses per slide. In addition, the user can check feedback as answered using the button at bottom-right of the slide pane.

2.1. Anchored Feedback

The notable feature of AFS is anchored feedback, i.e., three arrow-shaped indicators coordinating feedback to the target topic in the lecture slide. The deictic feature is designed for helping in avoiding the display of extra information, and it directly guides the user’s attention to the content of feedback.

In lectures, instructors need to pay attention to a variety of informative resources such as the lecture materials and student responses in order to probe students’ current understanding during instruction, and which imposes high cognitive load on them (Feldon 2007). Therefore, it is not difficult to expect that such lecture with classroom communication systems would more expense their working memory or might make them cognitive overloaded since too large amount of information is displayed on their computer screen (Anderson et al. 2003).

Likewise, this issue is similar to students. Considering lecture slides as learning materials, the display of extra information increases their cognitive load and can distract their attention away from the essential part of lecture slides (Sato et al. 2002, Sweller 2005).

With regard to this issue, anchored feedback converts the content of feedback into arrow-shaped indicators and allows the user to access the content only when necessary, in order to avoid displaying unrelated parts from the feedback. Moreover, such kind of access to feedback helps the user to recognize the direct relation between feedback and the target topic. The cognitive guidance (Mayer 2005, Suthers et al. 2003) decreases the viewer’s cognitive burdens to find the relation; however, previous classroom systems have not focused on the issue from this perspective.

3. EXPERIMENT 1

The purpose of this experiment was to evaluate the deictic function in anchored-type interface (AI) (Figure 3) by comparing it to a list-type interface (LI) without the deictic feature (Figure 4) from an instructor’s viewpoint.

In evaluation, the focus was on the cognitive guidance of anchored feedback, or coordinating the relation between feedback and the target topic in the lecture slide. In contrast, list-type interface used in text-based classroom systems (for example, Sato et al. 2002) does not support such deictic guidance to the viewer. In the present experiment, therefore, we evaluated influence of the direct guidance by comparison between AI and LI in the following conditions.

3.1. Method

Fourteen undergraduate and graduate students from varying majors and grades participated in the experiment. Although they were not lecturers, this was partly since it was difficult to gather a certain number of college instructors in our situation. However, the present experiment focused more on the cognitive aspect of feedback recognition than teaching activities in a real lecture, and therefore we assumed that the validity was maintained with the participants. In fact, ten of them had some teaching experience as private teacher or at private schools.

The participants were provided with a notebook computer and a projector screen connected to the computer in front of them; moreover, both screens were synchronized. The participants were divided into two groups and assigned one of the two interfaces shown in Figures 3 and 4 equivalently in order to maintain the counterbalance.

Each task consisted of a question & answer exercise, and 10 feedback questions were displayed on the screens. They were labeled with a serial number, and participants responded to 3 of them that were randomly selected by the experimenter, using the projector screen.

Each question was designed in a manner that it seeks explanation to the presented answer, based on junior high school curriculum to avoid the difference in prior-knowledge between the participants. They were provided with the complete reference information and preparation time at the beginning of tasks. After the
completion of 3 task slides, participants switched to the other interface and completed another set of the same tasks.

After each task, the participants answered a usability questionnaire. It comprised of questions probing the basic usability of various operations and screen views and the easiness of accessing feedback from several viewpoints: target topic recognition, the sequential access, and the ability to view multiple feedbacks at a glance.

3.2. Results

Table 1 presents results of the questionnaire survey based on a 5-point Likert scale (1: Strongly disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly agree). The basic usability between both the interfaces was not significantly different (item 1: $F(1,13) = 1.918$, n.s.; item 2: $F(1,13) = .000$, n.s.).

However, the ease of target recognition in AI was rated significantly higher (item 4: $F(1,13) = 6.952$, $p<.05$; item 8: $F(1,13) = 8.381$; $p<.05$). In the sequential access, the difference was nonsignificant (item 5: $F(1,13) = 2.537$, n.s.).

In addition, the ability to recognize the number of multiple feedbacks (item 3) was rated relatively higher in the AI (item 3: $F(1,13) = 4.613$, $p<.1$); however, the content overview of multiple feedbacks at a glance was rated lower, albeit the difference was nonsignificant (item 6: $F(1,13) = 2.925$, n.s.).

3.3. Discussion

Based on the results of the questionnaire survey, we found that the deictic function worked more effectively in directing feedback to the target topic with regard to both the understanding and responding to the feedback. Although there was nonsignificant difference in the basic usability questions (items 1 and 2), items 4 and 8 were rated higher by the participants, describing the ease of understanding the target topic and coordinating feedback to it. The results indicate that the deictic function guided participants to
Anchored Feedback

Table 1. Results of the usability questionnaire survey (One-way ANOVA, within-subjects)

<table>
<thead>
<tr>
<th>Item no.</th>
<th>Question</th>
<th>Mean AI</th>
<th>Mean LI</th>
<th>F-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>It was easy to use the interface.</td>
<td>4.50</td>
<td>4.29</td>
<td>1.918</td>
<td>.189</td>
</tr>
<tr>
<td>2</td>
<td>It was easy to view the screen.</td>
<td>3.43</td>
<td>3.43</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>3</td>
<td>It was easy to check how many questions were present on a slide.</td>
<td>3.21</td>
<td>2.43</td>
<td>4.613</td>
<td>.051</td>
</tr>
<tr>
<td>4</td>
<td>It was easy to understand the target topic of questions.</td>
<td>3.79</td>
<td>2.36</td>
<td>6.952</td>
<td>.021*</td>
</tr>
<tr>
<td>5</td>
<td>It was easy to read questions one by one.</td>
<td>3.64</td>
<td>3.07</td>
<td>2.537</td>
<td>.135</td>
</tr>
<tr>
<td>6</td>
<td>It was easy to grasp the content of multiple questions.</td>
<td>1.79</td>
<td>2.64</td>
<td>2.925</td>
<td>.111</td>
</tr>
<tr>
<td>7</td>
<td>It was easy to respond to questions.</td>
<td>3.64</td>
<td>3.43</td>
<td>.511</td>
<td>.487</td>
</tr>
<tr>
<td>8</td>
<td>It was easy to clarify which questions were mentioned.</td>
<td>3.86</td>
<td>2.79</td>
<td>8.381</td>
<td>.013*</td>
</tr>
</tbody>
</table>

Note: Judgments were made based on a 5-point Likert scale (1: Strongly disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly agree). * denotes a 5% significance level and **, a 1% significance.

The content of feedback with the target topic in a task slide, which contributed in facilitating feedback access using AI.

On the other hand, the result pertaining to item 3 suggested that the deictic function appeared to help participants to recognize the number of multiple feedbacks, whereas the result of item 6 implied that the AI might have diminished the ability to overview the content of multiple feedbacks, albeit it was nonsignificant.

This was partly because the AI concealed the descriptions that were not related to the current target topic, and therefore this feature might have hindered the ability to obtain an overview of multiple feedbacks. However, the design goal of AFS was to decrease the display of unrelated information at the same time and guide the user to the target topic; thus, we had expected this limitation.

In summary, the findings confirmed the validity of anchored feedback in guiding the user to coordinate feedback and the target topic. Moreover, they indicate that the deictic function helped the user to guide the listener’s attention to the current topic on a task slide during answer. These results imply the potential that the anchored mode allows the instructor to utilize one’s feedback not only for the recognition of feedback but also for sharing the current attention with listeners.

However, the results also imply that an overview of multiple feedbacks is useful at a stage during task. List-type interface allows us to view the whole items maintaining the time-series as its advantage, and therefore it would be helpful to introduce some additional functions to complement the strategy as maintaining the advantage of anchored feedback.

4. EXPERIMENT 2

Experiment 2 was conducted in a college lecture; its purpose was to investigate the practicality of AFS with the deictic feature. The present experiment involved 77 participants (Class A: with AFS (35) and Class B: without AFS (42) who were freshmen at a private university in Tokyo. The same instructor gave a lecture to both classes on an introduction to law.

4.1. Method

In Class A, the instructor used AFS for the slide presentation and feedback collection; on the other hand, in Class B, the instructor used only Microsoft PowerPoint in the lecture. After each class, we conducted a questionnaire survey for class evaluation and another usability survey only in Class A with the system.

Based on the usability survey, however, we found that some students in Class A experienced difficulties with keyboarding, and therefore we divided the students into two groups (A_1: students without keyboarding difficulties and A_2: students with keyboarding difficulties). The criterion for classification was based on whether they chose “Strongly agree” or “Agree” as a response to the question “It was difficult to type text using the keyboard when trying to send feedback.”

In analysis of class evaluation, we statistically compared only Group A_1 and Group B in order to observe the influence of factors between our system and keyboarding skills separately since it would have been impractical to analyze interaction between the factors (for example, keyboarding skills to the without-system group).
4.2. Results

Table 2 presents results of the usability survey. Overall, Group A.2 rated all the items lower than Group A.1, whereas the ANOVA revealed that all the items except for item 5 were significant between the groups.

On the other hand, with respect to the class evaluation, the ANOVA between Groups A.1 and B (Table 3) revealed that Group A.1 rated items 4, 5, and 7 significantly higher than Group B (item 4: \( F(1,64) = 11.062, p<.01 \); item 5: \( F(1,64) = 8.239, p<.01 \); item 7: \( F(1,62) = 14.050, p<.01 \)). In contrast, as shown in Table 3, Group A.2 rated all items lower than the other groups.

4.3. Discussion

In sum, first, we discovered that keyboarding difficulties considerably influenced the entire evaluation. Results of the usability survey revealed that Group A.2 (with the problem) rated all the items significantly lower than Group A.1 did (without the problem); moreover, Group A.2 rated the entire class evaluation lower than the other groups did, including the without--system group. This would be because AFS requires students to type text to send their feedback, and some users’ keyboarding difficulty influenced the entire evaluation.

The findings suggest that careful consideration should be given to students’ keyboarding skills when using our system or some other text--based feedback system in a lecture, although we could not identify precisely which student sent feedback through our system. Despite the fact that all the

<table>
<thead>
<tr>
<th>Item no.</th>
<th>Question</th>
<th>Mean A.1</th>
<th>Mean A.2</th>
<th>( F )-value</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I know how to send questions to the instructor.</td>
<td>3.28</td>
<td>1.70</td>
<td>15.844</td>
<td>.000**</td>
</tr>
<tr>
<td>2</td>
<td>I could ask questions when I did not understand anything during lecture.</td>
<td>3.04</td>
<td>2.20</td>
<td>4.813</td>
<td>.035*</td>
</tr>
<tr>
<td>3</td>
<td>I could easily ask questions because of the indicator function.</td>
<td>3.20</td>
<td>1.90</td>
<td>12.892</td>
<td>.001**</td>
</tr>
<tr>
<td>4</td>
<td>It was easy to understand what the question was related to using the indicator function.</td>
<td>3.16</td>
<td>1.90</td>
<td>8.855</td>
<td>.05*</td>
</tr>
<tr>
<td>5</td>
<td>I thought that some of questions raised by others related to my question.</td>
<td>2.88</td>
<td>2.30</td>
<td>2.580</td>
<td>.118</td>
</tr>
<tr>
<td>6</td>
<td>I found some questions raised by others that I had not thought of.</td>
<td>3.08</td>
<td>2.00</td>
<td>6.901</td>
<td>.013*</td>
</tr>
<tr>
<td>7</td>
<td>It was difficult to ask questions because other students would be watching my question.</td>
<td>3.12</td>
<td>2.00</td>
<td>6.934</td>
<td>.013*</td>
</tr>
</tbody>
</table>

Note. Judgments were made based on a 4-point Likert scale (1: Strongly disagree, 2: Disagree, 3: Agree, 4: Strongly agree). * denotes a 5% significance level and **, a 1% significance

<table>
<thead>
<tr>
<th>Item no.</th>
<th>Question</th>
<th>Mean A.1</th>
<th>Mean A.2</th>
<th>( F )-value</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I could concentrate during lecture.</td>
<td>3.04</td>
<td>2.20</td>
<td>2.86</td>
<td>.943</td>
</tr>
<tr>
<td>2</td>
<td>I think we had opportunities for questions and answers.</td>
<td>2.84</td>
<td>2.50</td>
<td>2.67</td>
<td>.752</td>
</tr>
<tr>
<td>3</td>
<td>I remember what the instructor explained in the lecture.</td>
<td>3.04</td>
<td>2.30</td>
<td>3.02</td>
<td>.010</td>
</tr>
<tr>
<td>4</td>
<td>Today’s lecture was interactive.</td>
<td>3.12</td>
<td>2.00</td>
<td>2.45</td>
<td>.001**</td>
</tr>
<tr>
<td>5</td>
<td>Today’s lecture was fun.</td>
<td>3.32</td>
<td>2.30</td>
<td>2.67</td>
<td>8.239</td>
</tr>
<tr>
<td>6</td>
<td>Today’s lecture pace was appropriate.</td>
<td>3.17</td>
<td>2.00</td>
<td>3.39</td>
<td>1.057</td>
</tr>
<tr>
<td>7</td>
<td>It was easy to ask questions to the instructor during the lecture.</td>
<td>3.17</td>
<td>2.30</td>
<td>2.40</td>
<td>14.050</td>
</tr>
<tr>
<td>8</td>
<td>I was not frustrated by the time the instructor answered other students’ questions.</td>
<td>3.17</td>
<td>1.90</td>
<td>3.33</td>
<td>.959</td>
</tr>
<tr>
<td>9</td>
<td>I think the instructor responded to student questions properly.</td>
<td>3.28</td>
<td>1.90</td>
<td>3.52</td>
<td>1.175</td>
</tr>
</tbody>
</table>

Note. Judgments were made based on a 4-point Likert scale (1: Strongly disagree, 2: Disagree, 3: Agree, 4: Strongly agree). * denotes 5% significance level and **, a 1% significance
participants in the experiment were freshmen who were expected with less keyboarding experience, it would be helpful to introduce some additional functions for such less experienced users to enable them to express their views.

On the other hand, the comparison between Group A (without keyboarding difficulties) and Group B revealed that our system increased students’ consciousness of interactivity. This was partly because the feedback feature facilitated their expressing views, and the results are derived based only on a lecture in the present experiment; however, they are coherent with the findings of previous research (Sato et al. 2002, Anderson et al. 2003).

In our observation, the instructor recognized break-out of all the student feedback during instruction and responded to most of them. On the other hand, he posed some questions in advance and gathered all the students’ feedback into a blank slide, in a way that positive answers were put on the left side and negative ones on the right. From the distribution, he grasped the patterns and used them for the following classroom discussion. Such use of spacious information was characteristic with AFS.

From these findings, we think our system have the potential to increase classroom interaction, and also the instructor can utilize the spacious information of anchored feedback in unique ways, although the proficiency level of users’ keyboarding skills should be confirmed in advance.

5. CONCLUSION

In this paper, we proposed a kind of feedback method termed anchored feedback and evaluated the interface in a CFS from two experiments. In the findings, we found several implications pertaining to the validity and practicality of AFS.

Experiment 1 was conducted to evaluate the deictic function of anchored feedback. The results indicated that the deictic feature was more efficient in directing the user to the target topic based on the content of feedback in the instruction slide. However, it was not so for overview of multiple feedbacks at a glance, in which list-type interface was better. Therefore, we should consider any complement of the overview feature in the following works.

On the other hand, in Experiment 2, we used AFS with the deictic feature in a lecture and found that our system increased the class interactivity, and the characteristic use of anchored feedback was observed such as the instructor acquired spacious information from arrow-shaped indicators’ distribution in the slide.

From the experiment, AFS can accommodate at least 30 to 50 users at the same time, and more various use of anchored feedback is expected based on the instructor’s idea particularly in ways of utilizing spacious information of the feedback direction and distribution.

In contrast, users’ keyboarding skill should be considered in advance to use AFS. It requires typing using their keyboard to send feedback, and therefore any confirmation or training for keyboarding will be essential to avoid the negative influence for their engagement.

Finally, our evaluation of the present study can be extended to only limited situations; therefore, further detailed examination is required. We believe that one of the problematic issues in classroom technology is cognitive overload in that too much information displayed through media might impede recognition of the essential part of a lecture for both the instructor and students, and consequently it would complicate utilization of the information. Thus, it would be important to resolve this issue and suggest better cognitive guidance in more efficient manners.

REFERENCE


