Analysis of Students’ Eye Movement in Relation to Contents of Multimedia Lecture

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Abstract: In this article, we report our analysis about relation between the content of lecture and the students' eye movement in order to clarify the criterion to capture image information for distance learning. We classified content of lecture into nine instructional process categories: introduction, presentation, explanation, illustration, assertion, query, reply, question, and response. As the result of analysis, we get the characteristic of students’ eye movement in each instructional process category in practical lecture. And our research suggests the practical guide for selecting of image information for distance learning.

1. Introduction

The rapid advancement of the Information Technology (IT) such as the Internet has been changing education, particularly distance learning. In the case of distance learning, lecture with multimedia material is shot by some cameras, and the image information is recorded and transmitted. It is necessary to convey the content of lecture effectively, so we need the criterion to decide what we should capture by camera.

In the previous work, they proposed some automatic shooting systems and archive systems for lecture (Kameda et al., 2000, Onishi et al., 2000). These works were interesting in the visual point of view. But, we propose that it is important to consider contents of lecture for selecting of image information. Since students depend on contents of lecture in order to decide what they look at, we pay attention to students’ eye movement.

Our purpose is to clarify the criterion to select image information for distance learning and WBT. Then, we report our analysis of how the students' eye movement is affected by the content of lecture.

2. Instructional process category

Lecture with multimedia material consists of lecturer, material and students. Multimedia material continues to be shown during the lecture. Students choose an object (material, lecturer and the other students) at which they look to get information. We define the style of this lecture as “multimedia lecture”. In this multimedia lecture, the roles of lecturer and material change according to the situation. In this research, we examine the roles of lecture and material which affect students’ eye movement.

A criterion is necessary to partition the multimedia lecture into parts based on contents. Then, we define “Instructional Process Category” referring to the past research of instructional analysis (Flanders, 1970, Hough et al., 1970, Mizokami et al., 1998) and teaching method. We classified contents of lecture into nine categories: introduction, presentation, explanation, illustration, assertion, query, reply, question, and response.

Introduction: Lecturer tells students about the preliminary knowledge and the outline of lecture so that he/she expects students to be motivated the lecture. In this process, lecturer gives students advanced organizer. We define this part as “introduction”.

Presentation and explanation: We propose that the process of learning multimedia material classifies into two parts, referring to process of learning text (Kintsch, 1994). First, they learn of multimedia material.
They try to recognize and understand the multimedia material in order to construct text-based model to replay and summarize the contents. We define this part as “presentation”. Next, they learn from multimedia material. They try to integrate information and knowledge in order to construct situation model to apply the integrated knowledge. We define this part as “explanation”.

Illustration: Lecturer shows a concrete example to help students understand. We define this part as “illustration”.

Assertion: Lecturer asserts his/her argument and tells his/her experience. We define this part as “assertion”.

Questions and Answer (query, reply, question and response): Lecturer often interacts with students by verbal communication in the lecture. We call this part “questions and answers”. We classify this part into four parts in detail. When speaker is the lecturer, we define as “query” and “reply”. On the other hands, when speaker is a student, we define as “question” and “response”.

3. Experiment

We have practiced TIDE (Trans-Pacific Interactive Distance Education) project between University of California Los Angeles (UCLA) and Kyoto University (Yagi et al., 2000, Murakami et al., 2001). “Japanese Economics” were offered from April to June 2001. Several professors of Kyoto University give this course. For Kyoto University students, this lecture is regarded as usual multimedia lecture. In this research, we select this distance lecture as experimental lecture.

Figure 2 shows the figure of classroom of Kyoto University. Left screen shows Web material, and right screen shows students of UCLA. Lecturer makes the lecture on the center of the classroom. In this situation, students’ eye movement changes depending on what they look at, among lecturer, students of UCLA on the screen, and material. Two cameras in the front of classroom recorded students so as to catch the direction of their eye movement. Whereas the camera behind the classroom recorded lecturer and two screens in order to check the contents of lecture. And, the first author attended all lectures and recorded the state of classroom in field notes. After that, we classified the recorded lecture into instructional process category.

We select two lectures as experimental lectures among course. Two lectures were practiced by different lecturer. Table.1 shows time of each category.

We extracted 9 students from each lecture as target of analysis. We checked what students look at per 10 second. Additionally in order to analysis in detail, we select some parts of lecture, which cover all categories, so we checked per second about the select data.

<table>
<thead>
<tr>
<th></th>
<th>introduction</th>
<th>presentation</th>
<th>explanation</th>
<th>illustration</th>
<th>Assertion</th>
<th>query</th>
<th>reply</th>
<th>Question</th>
<th>response</th>
</tr>
</thead>
<tbody>
<tr>
<td>lecture1</td>
<td>4:30</td>
<td>11:10</td>
<td>18:30</td>
<td>4:30</td>
<td>8:30</td>
<td>0:30</td>
<td>7:10</td>
<td>7:20</td>
<td>1:40</td>
</tr>
<tr>
<td>lecture2</td>
<td>4:00</td>
<td>20:00</td>
<td>12:30</td>
<td>9:40</td>
<td>5:20</td>
<td>2:00</td>
<td>5:30</td>
<td>4:00</td>
<td>3:00</td>
</tr>
</tbody>
</table>
We consider ratio of observation and pattern of eye movement as indicator. The ratio of observation is calculated by (the number of students looking at the object)/(the number of all students). The pattern of eye movement is based on cycle of eye movement and what student looks at first. We define cycle of eye movement as (when he/she looks at lecturer) + (when he/she looks at material next), or in the case of reverse order. We think that the continuous is important factor, so that we analyze the data by the following methods. If student looks at different object in only a second (for example, lecturer in 3 seconds, material in 1 second and lecturer in 4 seconds), we regard that student looks at same object continuously (above example, lecture in 8seconds).

4. Analysis

4.1 Result

Firstly, in order to clarify the character of ratio of observation on each category, we calculated average of the ratio of observation per 10 second on each category. The result shows Table 2.

Table 2 Ratio of Observation on each Instructional Process Category

<table>
<thead>
<tr>
<th></th>
<th>introduction</th>
<th>presentation</th>
<th>explanation</th>
<th>illustration</th>
<th>assertion</th>
<th>query</th>
<th>reply</th>
<th>question</th>
<th>response</th>
</tr>
</thead>
<tbody>
<tr>
<td>material</td>
<td>41.3%</td>
<td>81.3%</td>
<td>50.1%</td>
<td>93.5%</td>
<td>24.3%</td>
<td>22.2%</td>
<td>8.6%</td>
<td>6.6%</td>
<td>4.5%</td>
</tr>
<tr>
<td>lecturer</td>
<td>47.9%</td>
<td>17.4%</td>
<td>48.0%</td>
<td>6.5%</td>
<td>71.2%</td>
<td>57.8%</td>
<td>59.3%</td>
<td>20.3%</td>
<td>37.7%</td>
</tr>
<tr>
<td>students</td>
<td>10.8%</td>
<td>1.3%</td>
<td>1.8%</td>
<td>0.0%</td>
<td>4.5%</td>
<td>20.0%</td>
<td>32.1%</td>
<td>73.0%</td>
<td>57.8%</td>
</tr>
</tbody>
</table>

Secondly, we analyze eye movement of each student on each category. Results of analysis about introduction, presentation and explanation show figure 3-5. In these figures, 2 of y-axis shows looking at lecturer, 1 shows material and 0 shows no object.

Thirdly, we sampled cycles in these data, and add up them on each category. Histogram of cycles about presentation and explanation show figure 6,7. The x-axis shows time of cycle and the y-axis shows the number of times. The average of cycle of presentation is 11.60 second and standard deviation is 3.38, whereas the average of cycle of explanation is 20.21 second and standard deviation is 6.85.

4.2 Relation between Category and Eye Movement
We discuss the relationship between instructional process category and eye movement from the results of analysis described in 4.1.

Introduction: The ratio of looking at material is much the same the ratio of looking at lecturer from Table 2. As concerns the pattern of the eye movement, students gazed at lecturer at first, and next looked at material from Figure 3. It is thought that they tried to acquire advance organizer from the lecturer.

Presentation: The ratio of looking at material is very high, 81.5%, from Table 2. From Figure 4 and Figure 6, students mainly stared at material for about 15 seconds and sometimes peered at lecturer for about 3 seconds. They learned of multimedia material during presentation, so that they mainly stared at material. And they looked at lecturer in order to complement understanding.

Explanation: From Table 2, the ratio of looking at material is close to the ratio of looking at lecturer. From Figure 5 and Figure 7, the cycle of eye movement is about from 19 seconds to 29. The cycle is the longest than other course process categories. They learned from multimedia material during explanation, so that students stared at the object which they regard as important to understand the lecture.

Illustration: The ratio of looking at material is the highest, 93.5%, from Table 2. As the reason of high ratio, it is thought that material offered main information source.

Assertion: The ratio of looking at lecturer is very high, 71.2%, from Table 2. They gaze at lecturer because of interaction between lecturer and students.

Question and answer: Generally, students looked at speaker. But in the case of "query" about material, they change their focuses on material and lecturer by turns frequently. It is thought that students tried to grasp information of lecturer and material in order to answer to the question.

4.3 Guideline

Based on the result of analysis, we discuss the practical guide for select of image information. In introduction, we should select image of lecturer for several seconds first in order to give advanced organizer. In presentation, we basically select image of material, but we occasionally insert image of lecturer. In explanation, we should present image of material and lecturer by turns for about 20 seconds. In illustration, we should select image of material. We should select image of lecturer in assertion. In questions and answers, we basically select image of lecturer, except the case of the query about material. In query about material, we should alternate image of lecturer and material frequently.

5. Conclusion

In this article, we report our analysis about relation between the contents of lecture and the students' eye movement in order to clarify the criterion to select image information for distance learning and WBT. As the result of analysis, we get the characteristic of students’ eye movement in each instructional process category in practical lecture. And based on these results of analysis, we propose to apply these results to selecting image for distance learning.

Reference

Hough, J.B., Duncan, J.K. (1970) Teaching: Description and Analysis, Addison-Wesley