AirTransNote: An Instant Note Sharing and Reproducing to Support Students Learning

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Abstract

We developed AirTransNote, an interactive learning system augmented by digital pens and PDAs for each student. All notes written on regular paper sheets are immediately digitized and transmitted to teacher’s PC, and recognized to generate feedback on responses. Our system helps students to recall process of thinking by reproducing drawings on a projected screen. We conducted an experimental lecture session at a senior high school, and observed student’s reflective utterance while reproducing notes.

1. Introduction

The evolution of mobile and wireless networking technologies accelerate their educational use. Mobile devices have been applied to classroom settings in order to encourage in-class participation[9], to improve interaction on a university campus during lectures as well as small meetings[2], and to facilitate inquiry learning activities including field work at elementary school[12]. The ad hoc classroom system[1] enables students to access learning contents even in outdoor. These systems employ touch panel or tablet of PDAs as inputs. The tablet interface is suitable for responding selective answers or annotating, but it is not intuitive for note taking due to the small screen size.

We have developed a hybrid interactive and collaborative learning system “AirTransNote” (ATN) [5, 4] which utilize a digital pen and a PDA per student (see Figure 1). The aims of ATN are: (1) to activate communication in class, (2) to help both the teacher and students focus attention on students’ learning processes, and (3) to facilitate student’s reflective thinking at lecture. ATN collects students’ handwritten drawings on paper by digital pens, and transmits them to a teacher’s PC via wireless connection of PDAs immediately. A teacher can browse students’ notes, and show them with a projector (see Figure 2). ATN can also give feedbacks to the students by showing on PDA screen (see Figure 3). Since students are allowed to submit their free handwriting, ATN is more flexible than selection-based response analyzers[3]. Moreover, answering by handwriting on paper is more natural for students, and it has advantage on problem solving activity than tablet use[7].

In terms of enriching classroom capabilities, there are several researches focusing on augmenting facilities by embedding devices to environment[10, 11]. But modifying interior of classrooms costs higher in general. Thus we chose lightweight approach by bringing mobile appliances to realize augmented classrooms for conventional ones.

Figure 1. ATN Mediator: PDA and digital pen for capturing student’s note response in classroom
In this paper we show findings from our experimental lecture session with sharing and reproducing students’ note by ATN system at a senior high school.

2. Key Features of AirTransNote

Before describing experimental setting, we briefly explain key features of ATN. Please refer [5, 6, 4] for details of our ATN system.

Reproducing of note The captured student note consists of a sequence of coordinates with generated time. The teacher can reproduce the students’ note by manipulating a time slider (Figure 5 right) horizontally and play forward/backward. The representation of playing is similar to Explanogram[8], but ATN shows a pseudo pen to emphasize both drawing and non-drawing movement between inks.

Handwriting recognition and feedback The students’ notes are recognized by regions, and the results are shown on both teacher’s PC (Figure 2) and student’s PDA (Figure 3). Based on the results, students can get feedback on their learning.

Dynamic rearrangement of student panels ATN has a rearrangement function with the recognized result. The teacher can select one region for classification. Figure 4 shows an example of dividing into six groups: \{17,20,36\}, \{25,30,33,34\}, \{03,12,37\}, \{05,06,07,...,42\}, \{01,02,10,31\}, and \{04,09,13,32,41\}. The teacher and students can see the tendency of responses intuitively.

3. Experimental Lecture

To investigate the effect of immediate handwriting sharing and reproducing on students’ learning, we performed an experimental lecture at a senior high school.

3.1. Teaching contents

We chose a topic that extending the definitions of trigonometric functions for the lecture. Students were already learned the basic definitions of the trigonometric functions for 0 to 90 degrees. To introduce definitions of the trigonometric functions over 90 degrees, we planned the following procedure to consider cosine 120 degrees.

1. First, the teacher asks the students to draw a triangle which has 120 degrees on worksheet.
2. The teacher shows some triangles drawn by students, and explains a triangle that has 120 degrees is no longer a right-angle triangle.
3. Then the teacher introduces definition of angle which is necessary for defining trigonometric functions over 90 degrees. The base of angle is defined by positive part of x-axis, and the angle increases on counterclockwise.
4. To confirm the definition of angle, the teacher asks to draw lines which make angles of 225, 510 and −1000 degrees respectively. Also the students required to draw arcs or convolutions.

5. The teacher checked the responses by showing and reproducing handwritten drawings.

6. After confirming the definition of angle, the teacher posed question of cosine 120 degrees.

7. The teacher introduces how the cosine 120 degrees should be considered.

8. The students were asked to fill blanks with sine and tangent of 120 degrees based on the definitions of trigonometric functions. If the filled response is correct, “correct” message is displayed on PDA.

To recognize handwritten text filled in blanks properly, the students needed to calibrate the drawing position on paper. Therefore we explained the usage of ATN mediator in the previous day to introduce the method of calibration. We planed to ask all (forty) students in the class to participate. However the wireless connection of PDA was unstable at the preliminary session. Thus we asked twenty-three students to use the ATN mediator in the lecture.

At the beginning of the lecture, we distributed the PDAs randomly to shorten the startup period. The relationship between PDAs and students were mapped by post-binding method employed by RFID remote[6]. Thus the layout of student panels on the ATN Browser matched to the real seat arrangement of student after the procedure 5.

3.2. Findings from observation

Figure 5 represents the students’ notes in our experimental lecture, and Figure 6 shows the scene of the lecture. The function of reproducing handwritten drawings was effective to know whether the student understood the definition of angles or not. Because the teacher and students could recognize the direction and beginning point of arcs or convolutions which represent angles. Regarding the reproducing handwritten drawing, we observed two notable phenomena occurred in the lecture. The one was the teacher and the students could recognize the captured processes of answering in detail by reproducing. During the reproducing one student’s drawing convolutions of 510 degrees, her pen stopped and vibrated for a moment, every 180 degrees on the x-axis. We could imagine that she had calculated the rest of angles during drawing of the convolutions, and such action was not exposed unless the digitized pen captured her first experience of problem solving. The other was that
the students were able to concentrate on the process. While reproducing the other student’s note, he said “I drew the angle line first, then the convolutions.” His utterance expresses that he focused on the other students’ process, and compared with his performance. According to the observations, the reproducing function of ATN Browser facilitates the students not only to focus on the answering processes but also to compare them with their own process.

3.3. Result of questionnaire

We conducted a questionnaire survey after the lecture. Twenty-nine students answered (nine male and nineteen female, seventeen used pen and twelve not). Table 1 shows the average scores. According to the chi-square test, the distributions of ratings significantly differed on the three items: “Did you satisfy with the lecture?” ($\chi^2(3)=11.91$, $p<.01$), “Did you actively participate to the class?” ($\chi^2(2)=9.09$, $p=.011$), “Did you explain your idea well?” ($\chi^2(3)=7.81$, $p=.050$). Considering the result, students who used pen felt that he/she participated to the class actively by publicizing answers, and then they satisfied with the lecture. Incidentally, both group students rated relatively higher in “Did you feel the other’s answers were useful?” item than others.

We also gathered feelings of lecture with pen for pen-used group. More than 80% of students rated positive value in the three items: “The lecture with pen was fun,” “I could actively participate than usual lectures,” “I want to take the lecture with pen again”. According to the result, the note publicizing function of AirTransNote has possibility to make the students positive in lecture. However, the rating for “I think anonymous publicizing is better” was controversial. We consider the students wanted to proud of nice answer, but they feel uneasy when the reply was wrong. The teacher could relief the uneasy feeling by accepting the misunderstanding as necessary process of learning.
Table 1. Questionnaire Result (Comparison of with/without pen used)

<table>
<thead>
<tr>
<th>Questionnaire Item</th>
<th>With Pen</th>
<th>Without Pen</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Did you enjoy the lecture?</td>
<td>2.29, 0.84</td>
<td>2.00, 0.60</td>
</tr>
<tr>
<td>(2) Did you understand the contents?</td>
<td>1.65, 0.93</td>
<td>1.17, 0.58</td>
</tr>
<tr>
<td>(3) Did you satisfy with the lecture?</td>
<td>1.82, 1.07</td>
<td>1.33, 0.49</td>
</tr>
<tr>
<td>(4) Did you concentrate on the lecture?</td>
<td>2.19, 0.91</td>
<td>1.64, 0.81</td>
</tr>
<tr>
<td>(5) Did you actively participate to the class?</td>
<td>2.38, 0.89</td>
<td>1.67, 0.65</td>
</tr>
<tr>
<td>(6) Did you compare your answer with others?</td>
<td>2.00, 0.94</td>
<td>1.92, 0.52</td>
</tr>
<tr>
<td>(7) Did you feel the other's answers were useful?</td>
<td>2.18, 0.81</td>
<td>2.17, 0.58</td>
</tr>
<tr>
<td>(8) Did you explain your idea well?</td>
<td>1.56, 1.15</td>
<td>1.00, 0.60</td>
</tr>
<tr>
<td>(9) Can you explain the contents to others?</td>
<td>1.29, 1.16</td>
<td>0.58, 0.52</td>
</tr>
</tbody>
</table>

4-point scale: Yes < 3, 2, 1, 0 > No  (** denotes 1% significant, * for 5% significant.)

4. Conclusion and Future Works

We applied ATN system to a mathematics lecture which introduces definitions of trigonometric functions for extended angles. Our lecture design aimed at reinforcement by visual effects of note reproducing. We could observe that the students compare their note with others. In addition they could mind the response process with reproducing. The questionnaire results also showed that ATN can facilitate positive participants and improve satisfaction.

For the students, reproduced note is easier to recall their own externalized thinking than static drawing on paper and blackboard, and to notice what they thought. We cannot provide the similar effects unless recording and replaying of the problem solving process by video cameras. ATN has advantage to augment the effect with a conventional classroom setting.

Some students lost part of their note since they put hands between the pen and the sensors when capturing. The trouble can be reduced by introducing another sensing technology like "Anoto." Rather, we must discuss to complete the methodologies how to design such cooperative and dynamic aspects of learning in a classroom.

References


