AirTransNote: An Instant Note Sharing and Reproducing System 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. Also since the students' drawings can be projected on a screen, our system helps students to recall their thought process. We conducted an experimental lecture session at a senior high school, and observed student responses while using AirTransNote.*

1. Introduction

The evolution of mobile and wireless networking technologies has accelerated 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 learning activities including field work at an elementary school [12]. The ad hoc classroom system [1] enables students to access learning contents even in the outdoors. These systems use touch panel or tablet of PDAs as inputs devices. 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.

To rectify that shortcoming, we have developed a hybrid interactive and collaborative learning system, "AirTransNote" (ATN) [5, 4] which utilizes a digital pen and a PDA per student (see Figure 1). The aims of ATN are: (1) to facilitate communication in class, (2) to help both the teacher and students to 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. A teacher can browse students' notes, and project them on a screen using a projector (see Figure 2). ATN can also give feedback to the students by pointing on the PDA screen (see Figure 3). Since students are allowed to submit their handwriting, ATN is more flexible than selection-based response analyzers [3]. Moreover, answering by handwriting on paper is more natural for students, and it is better on problem solving activity than using tablet PC [7].

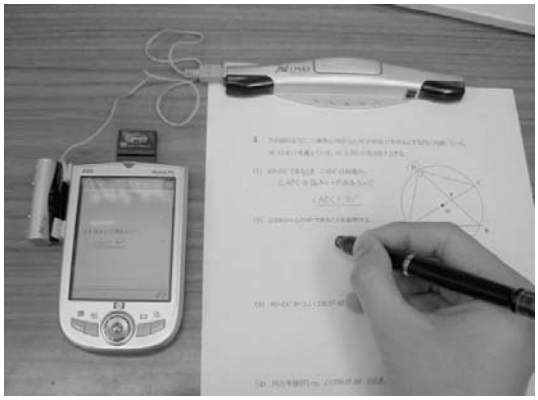

Figure 1. ATN Mediator: PDA and digital pen for capturing student's note response in classroom

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

In this paper we present findings from our experimental lecture session on sharing and reproducing students' note by ATN system at a senior high school.

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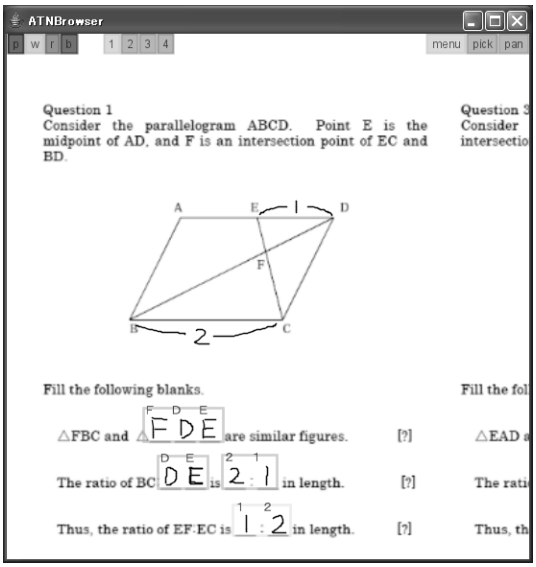

Figure 2. Zoomed-in view for projecting detail of student note (ATN Browser)

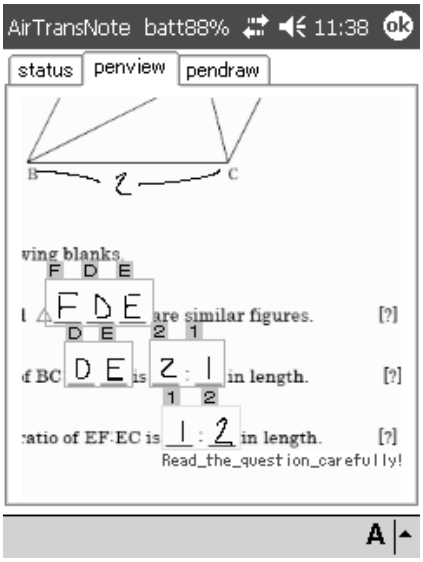

Figure 3. Student checks note, recognized result, and message on ATN Mediator

2. Key Features of AirTransNote

Before describing experimental setting, we briefly explain key features of ATN. Please refer to [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 pen movement between inks.

Handwriting recognition and feedback The teacher can set regions to recognize students' notes on worksheets in advance. The recognized result text is shown on both teacher's PC (Figure 2) and student's PDA (Figure 3). If the teacher prepares correct answers associated to each region, students can get feedback on PDA screen.

Dynamic rearrangement of student panels The recognized text can be used to rearrange of notes. Figure 4 shows a rearrangement result, caused by teacher's region selection. In this case, the notes are divided into four groups by responses: "DE", "DF", "ED", and no-answer group. The teacher and students can recognize the tendency of students' responses by watching the view of classification. The rearrangement function still works without the teachers preparing correct answers.

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

Our lecture topic was the definitions of trigonometric functions. Students had already learned the basic definitions of the trigonometric functions for 0 to 90 degrees. To introduce definitions of the trigonometric functions higher than 90 degrees, we planned the following procedure to consider cosine of 120 degrees.

1. First, the teacher asks the students to draw a triangle of 120 degrees on worksheet.

2. The teacher projects on the screen some triangles drawn by students and explains that a triangle that has 120 degrees is no longer a right-angled 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.

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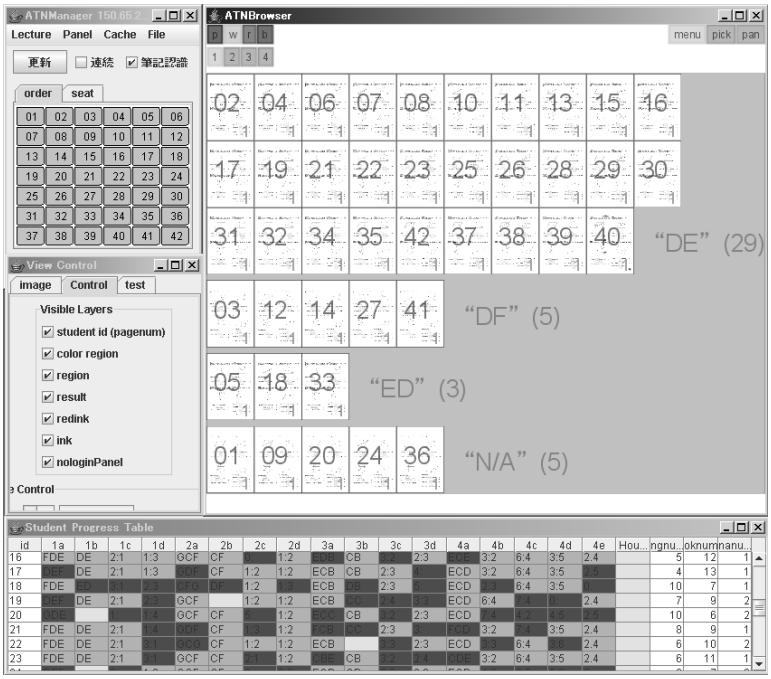

Figure 4. Dynamic rearrangement of student panels by recognized text (ATN Browser)

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 are required to draw arcs or convolutions.

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

6. After confirming the students' understanding of 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 are asked to fill in the 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. We had 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 students 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 reproducing handwritten drawing, we observed two notable phenomena. One, 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. And two, 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 remark shows that he focused on the other students' process, and compared with his performance. According to the observations, the reproducing function of ATN Browser facilitates

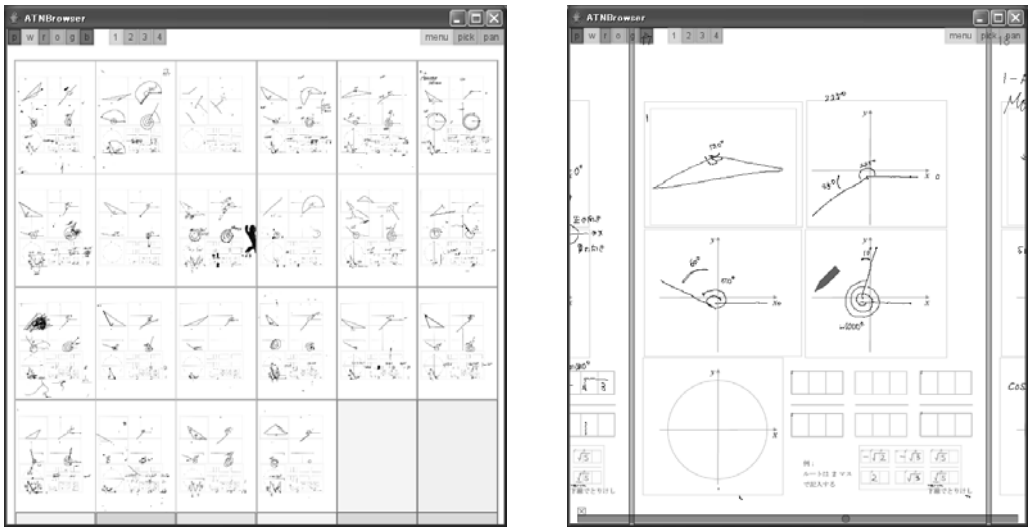

Figure 5. Student notes taken in our experimental lecture (left: overall view; right: detailed view with reproducing time slider and pseudo pen)

Figure 6. Scenes of the experimental lecture

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 survey after the lecture. Twenty-nine students answered (nine male and nineteen female and one unknown, seventeen used pen and twelve did not). Table 7 shows the average scores. According to the chi-square test, the distributions of ratings significantly differed on the three items: "Are you satisfy with the lecture?" ($\chi^2(3)=11.91$, $p<.01$), "Did you actively participate in the class?" ($\chi^2(2)=9.09$, $p=.011$), "Did you explain your idea well?" ($\chi^2(3)=7.81$, $p=.050$).

Considering the results, students who used pen felt that they participated in the class actively by publicizing answers, and they were 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 correct answers, but they feel uneasy when their reply was wrong. The teacher could relieve the uneasy feeling by accepting the misunderstanding as necessary process of learning.

4. Conclusion and Future Works

We applied ATN system to a mathematics lecture which introduces definitions of trigonometric functions for ex-

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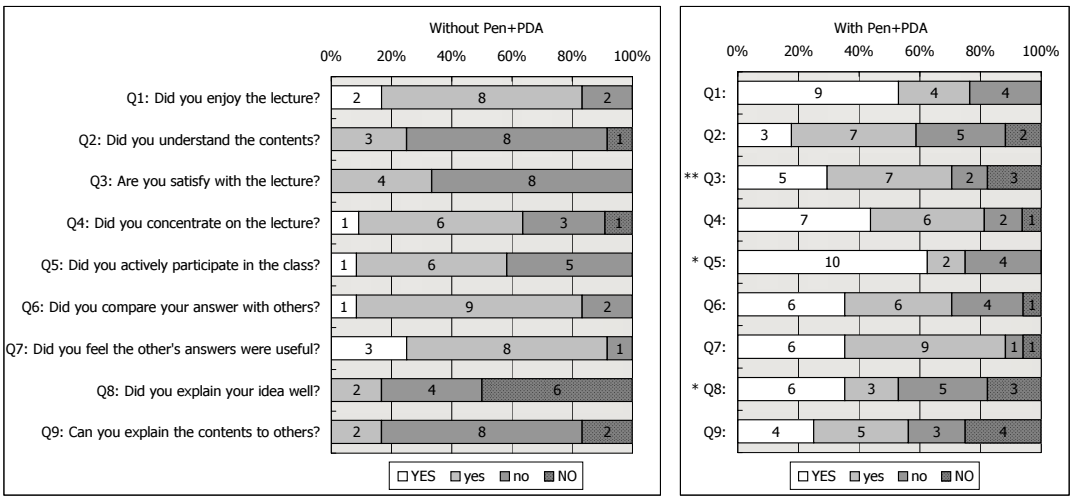

Figure 7. Comparison of questionnaire results with/without pen and PDA

tended angles. Our lecture design aimed at reinforcement by visual effects of note reproducing. We could observe that the students could compare their notes with others. In addition, they could visualize 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. Rather, we must discuss to complete the methodologies how to design such cooperative and dynamic aspects of learning in a classroom.

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References

[1] C. Y. Chang and J. P. Sheu. Design and Implementation of Ad Hoc Classroom and eSchoolbag Systems for Ubiquitous Learning. In *Proceedings of WMTE 2002*, pages 8–14, Aug. 2002.

[2] I. Demeure, C. Faure, E. Lecolinet, J. C. Moissinac, and S. Pook. Mobile Computing to Facilitate Interaction in Lectures and Meetings. In *Proceedings of DFMA 2005*, pages 359–366, Feb. 2005.

[3] C. W. Huang, J. K. Liang, and H. Y. Wang. EduClick: A Computer-Supported Formative Evaluation System with Wireless Devices in Ordinary Classroom. In *Proceedings of Int. Conf. on Computers in Education (ICCE)*, pages 1462–1469, 2001.

[4] M. Miura and S. Kunifuji. Hybrid Approach of Augmented Classroom Environment with Digital Pens and Personal Handhelds. In *Proceedings of the 10th International Conference on Knowledge-Based Intelligent Information and Engineering Systems (KES2006)*, pages 1019–1026, Oct. 2006.

[5] M. Miura, S. Kunifuji, B. Shizuki, and J. Tanaka. Augmented Classroom: A Paper-Centric Approach for Collaborative Learning System. In *Proceedings of 2nd Int. Symposium on Ubiquitous Computing Systems (UCS2004), LNCS 3598*, pages 104–116, Nov. 2004.

[6] M. Miura, S. Kunifuji, B. Shizuki, and J. Tanaka. AirTransNote: Augmenting Classrooms with Digital Pen Devices and RFID Tags. In *Proceedings of WMTE 2005*, pages 56–58, Nov. 2005.

[7] S. Oviatt, A. Arthur, and J. Cohen. Quiet Interfaces that Help Students Think. In *Proceedings of ACM UIST 2006*, pages 191–200, Oct. 2006.

[8] A. N. Pears and C. Erickson. Enriching Online Learning Resources with "Explanograms". In *Proceedings of ISICT 2003*, pages 261–266, Sept. 2003.

[9] M. Ratto, R. B. Shapiro, T. M. Truong, and W. G. Griswold. The ActiveClass Project: Experiments in Encouraging Classroom Participation. In *Proceedings of CSCL 2003*, pages 477–486, June 2003.

[10] Y. Shi, W. Xie, and G. Xu. Smart Remote Classroom: Creating a Revolutionary Real-Time Interactive Distance Learning System. In *Proceedings of ICWL 2002, LNCS 2436*, pages 130–141, Aug. 2002.

[11] X. Vila, A. Riera, E. Sánchez, M. Lama, and D. Moreno. A PDA-based Interface for a Computer Supported Educational System. In *Proceedings of ICALT 2003*, pages 12–16, July 2003.

[12] J. C. Yang and C. H. Chen. Design of Inquiry Learning Activity Using Wireless and Mobile Technologies. In *Proceedings of ICALT 2006*, pages 398–402, July 2006.