Improving Learning via Tablet-PC-based In-Class Assessment

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We evaluated the use of a Tablet-PC-based classroom presentation system in the first author's introductory computer science class in Fall 2005. The presentation system, Classroom Presenter [1], supports student wireless submission of digital ink answers to in-class exercises. We evaluated the hypothesis that the use of such a system increases student learning by: (1) increasing student focus and attentiveness, (2) providing immediate feedback to both students and instructor about student misunderstandings, (3) enabling the instructor to adjust course material in real-time, and (4) increasing student satisfaction. We evaluated each of the above four parameters by means of classroom observation, surveys, and interviews. In addition, we evaluated the increase in student learning by comparing performance for students in the pilot study class with performance for students in the other four classes in which instructors taught the same material.

Classroom Presenter

Using Classroom Presenter [1], an instructor teaches using slides on a Tablet PC, annotating the slides by writing on them with digital ink. The slides and ink are displayed on a large screen and on the instructor's and students' Tablet PCs. The students handwrite answers on their Tablet PCs, then anonymously submit the digital ink answers to the instructor via a wireless network.

Shown in Figure 1 is an example of use of Classroom Presenter in MIT's introductory computer science course, 6.001, in Fall 2005.

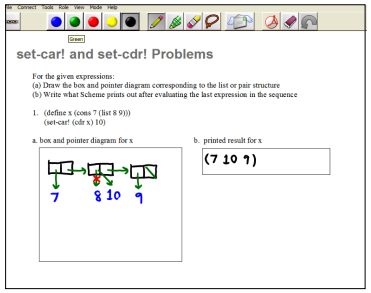

Figure 1. Student answer in Classroom Presenter

Methodology

1. Students were assigned randomly to recitation sections of 6.001 (introductory CS), which met for 50 minutes twice a week.

2. Tablet PCs and Classroom Presenter were introduced into the class after the first exam (in 5th week of 15).

3. The instructor brought Tablet PCs to class, and typically spent approximately 10 minutes reviewing material, 35 minutes having students work exercises, and 5 minutes summarizing.

4. Students wirelessly submitted answers.

5. Data was collected: two surveys, one at beginning of Tablet PC use, one at end; multiple timed 5-minute observation periods; short after-class interviews with students.

6. Student performance was assessed via two exams, a final exam, 5 programming projects, weekly problem sets, and class participation.

[1] Anderson, R., et. al. Experiences with a tablet-pc-based lecture presentation system in computer science courses. *Proc. of SIGCSE '04.*

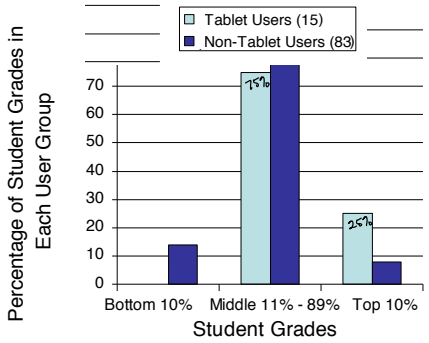

Figure 3. More of the Tablet students were in the top 10% than expected, fewer in the bottom 10%

Learning Results

The students in the Tablet PC class performed better than would be expected by chance. The instructor's engagement style of teaching resulted in the Tablet PC students comprising 35.7% of students in the top 10% of the 6.001 class on the first exam (prior to introduction of Tablet PCs). They comprised only 15.3% of all students taking 6.001. After use of the tablets, they comprised 44.4% of students in the top 10% of the class in final grades—an 8.7% increase over exam one performance, and a 29.1% increase over the expected 15.3%. Further, 25% of Tablet PC students were in the top 10% of the class. (See Figure 2.) The Tablet PC students also were less apt to perform poorly: No student performed in the bottom 10% of the entire 6.001 class, and only 8.3% of the Tablet students placed in the bottom 25% of the class. Further, no student received a D or an F. (In the class of 98 students, 4 students made Fs, 3 made Ds.)

Interaction Results

Focus: 14 of 15 students spent 90% of class time focused and attentive; the remaining student spent 80%-85% in the same manner. Deviations from focus were due to students already knowing the material; they did class homework instead.

Feedback: 75% of class time was spent providing feedback to students. All students whose grades placed them in the middle third of the class said that feedback helped them. The top third of students benefited on the few exercises on which they had difficulty. Students in the bottom third reported that they benefited but felt that they needed more time spent on the answers that they did not understand.

Adjustment of course material: The instructor postponed introduction of new exercises in 3 of 13 class sessions in order to spend more time on misunderstood concepts. She introduced new, more challenging exercises in 2 sessions.

Student satisfaction: Student satisfaction was extremely high, but can be measured more precisely when based upon performance in class. The top third of students in the Tablet class perceived 6.001 as much easier than anticipated because they were able to get immediate feedback when they had difficulty. The 3 students who felt that they did not benefit from the Tablet had the bottom 3 grades in the class. (These students may have benefited, however, since their grades were 1 B and 2 Cs.)

Current Study

Our results are promising, but the sample size was small (15) and there was no control group. We repeated the study in Spring 2006: The first author taught one 6.001 recitation with Tablet PCs and one without. We are now analyzing the data.

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