

Fall 2010 Tablet PC Experiments

SLICE Technical Note

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We've run two small experiments this past semester, and plan to run larger versions in the Spring, 2011, semester. This short note describes the fall experiments, and talks a bit about plans for the Spring.

The experiments were run in two classes: Programming Studio (CS 242, TA Charlie Meyer) and Data Structures (CS 225, Prof. Cinda Heeren). For the most part, these experiments were done just to test that the systems we developed worked, but we got some encouraging preliminary results, especially for the Studio. In general, the work in these courses represents, I think, good directions for Slice.

Programming Studio

This is a course in which students get together weekly and present and discuss the programs they wrote that week. In other words, the students engage in a weekly code review. The course is intended to help students improve their coding skills by practicing and being critiqued (as in a studio in an architecture school), and to improve their oral presentation skills. We reported on this course in SIGCSE in 2007 [WK07].

The biggest challenge in this course, as we noted in the 2007 paper, is maintaining the quality of the discussion in the sections. Programs are difficult to follow and somewhat tedious to read, so that discussions can degenerate into a superficial tour through the presenter's program, interspersed with superficial comments from the others. The studio staff have tried many strategies to overcome this problem. Using Tablet PCs is a new strategy that shows promising preliminary results.

To set the stage, the Studio has since its inception about five years ago worked like this: Each section has 4-6 students, plus a moderator, and runs for two hours once a week. Each student is given 20-25 minutes to present their weekly programming. The class sits around a table, and the presenter displays his or her code on a large monitor, either connecting it to their laptop or downloading the code from the web. The code usually consists of several files, a total of several hundred to several thousand lines. The presenter goes through it in his or her preferred order, while other students and the moderator comment.

The Tablet PC set-up works like this: Every student has a Tablet PC at the table. The presenter loads his or her files from a server onto the tablet, and all tablets in the class see them at the same time. The presenter goes through the program, in the same way as before, but can now annotate over the

program, the annotations showing up on every tablet, as well as on the large display. In fact, every student can write digital ink comments on the code, and all those comments are shared on every tablet. In short, the system is a shared whiteboard, with the presenter's programs serving as a background image. Furthermore, each student can independently navigate through the program, switching to different files and scrolling, independent of the presenter. The set-up is shown in Figure 1.



Figure 1: Programming Studio discussion with Tablet PCs

In the Fall semester, there were about 20 sections of 242. We were able to introduce the tablets in two sections, starting in late October, for a total of four weeks. The students had, of course, been in the Studio the entire semester, using the original class structure, so they could compare the classes with and without tablets.

There were only eleven students in the two sections, so this is hardly definitive, but the results are encouraging. The results of our end-of-semester survey are given in an appendix to this note. To give some of the highlights: all but one student found the discussion with tablets either a little more or a lot more engaging than without it; seven of eleven felt they were able to understand presented programs either a little or a lot better with the tablets than without (no one report they were *less* able to do so). Nine of eleven strongly agreed with the statement “The ability to ask questions and make comments in writing, instead of just orally, allows me to use pictures, which often work better when discussing programming.”

But there's more! Someone suggested that if the tablets were helping students stay more engaged in the class – if, as we hoped, the discussions were livelier – this would show up as an increased amount of talking. (Communication is not zero-sum; we're adding a new communication channel – the networked tablets – but that doesn't mean the old channel – speaking – will necessarily be used less.) We have an

idea of how to test this – see below – but we wanted to do a preliminary test before investing time in a bigger experiment. The hypothesis is more of a “wouldn’t it be nice if” kind of thing at this point. Well, it turned out we had one we didn’t even know about. Charlie Meyer, the TA for these two sections, had been keeping records, for grading purpose, of when students made comments on other students’ code – just making a tick mark for each occurrence. It’s not complete, and may not be entirely objective, but there is no reason to think his record-keeping was affected by the presence or absence of tablets. Charlie had previously noted that, while the tablets seemed helpful in both sections, one section clearly took to them more than the other. Sure enough, in the less affected class, the total number of comments, as counted by Charlie, changed little when the class switched to tablets. But in the other class, the number of oral comments went up about 50% when the tablets were used!

So, we’ve decided to do an experiment in the spring semester to test this hypothesis. In a few sections, we’re going to make each student record everything they say. In those sections, we’ll switch between tablet use and non-tablet use (on perhaps a three-week cycle), and analyze the recordings for the semester. We figure a simple analysis would be just to see when each student’s recording exceeds a certain volume level and, more or less, add up those numbers. (Well, probably something more sophisticated will be needed; Karrie Karahalios does something similar in her “Conversation Clock” [BK07], but in real time.) We think the experiment will be relatively easy to run, and if the hypothesis is true, we will be able to say that, on a perfectly *objective* basis, the tablets enliven the studio discussions.

Data Structures

CS 225, Data Structures, taught by Cinda Heeren, is a typical large class in our department. “Data structures” is the traditional second programming course in almost all CS departments. At Illinois, it is taken mainly by sophomores (some freshmen), and had an enrollment this past semester of about 200. It is taught in a single section in our large lecture hall, room 1404.

I have been thinking for a long time about how Tablet PCs could be of use in large lectures, where only a fraction of the students would have them. (One earlier effort that intrigued me was the UCSD experiment on in-class blogging, where a few Tablet PC-equipped students took notes on the teacher’s slides in class, which were shared in real time, via the web, with all the students who had traditional laptops [SG07].) I have always felt that the first-order effect of tablets, whether in small or large classes, would be to let the teacher better see what the students are learning, by wirelessly connecting their computers to a “dashboard” display showing what was on their desktop. This would allow the teacher to adjust what she is doing in the class. In a small class, it is possible to have all students use tablets, and let the teacher see all of their work (with a large enough display); for example, DyKnow classrooms typically have twenty or so seats.

In this class, we tried a simple compromise: give the tablets to a subset of the students, and let the instructor see just those students’ work. This might give the teacher a skewed idea of what is happening, but the only real risk is that the class might appear to understand the lecture so well that the teacher decides to speed up, when what is really needed is for her to slow down. However, it seems

more likely that this is what is happening *right now* – the teacher is already teaching at what she considers to be the right pace, and is getting no evidence to the contrary. So at worst, the teacher’s information will be about the same as it is now.

In any case, that is what we decided to try. We originally thought we would hand tablets out to nine students in each class, chosen randomly from among those who agreed to participate. However, we ran into two problems: First, we did not have nine working tablets with sufficiently good batteries to survive for an hour (1404 has no power to individual seats). Second, when we displayed nine student tablets on the dashboard, they were too small to be read easily. We ended up using only four tablets per class. The set-up is shown in Figure 2.

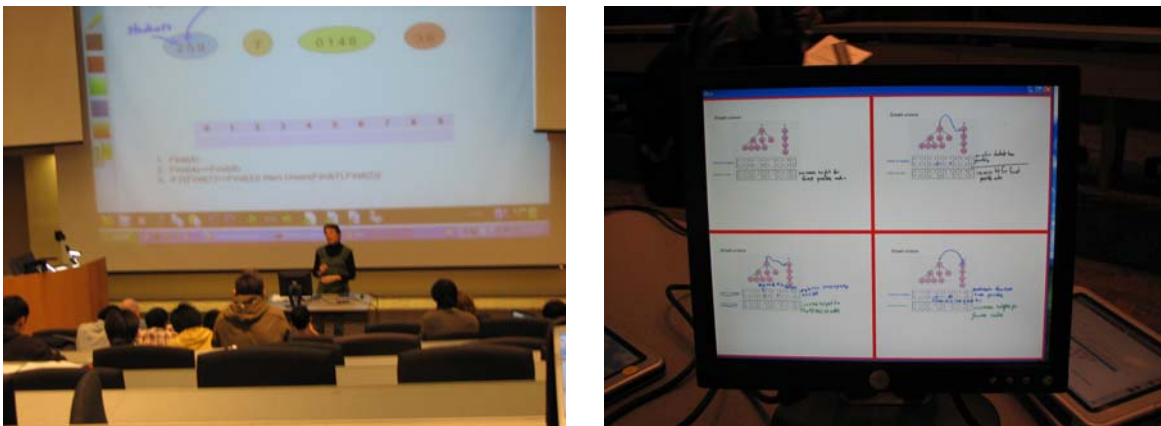


Figure 2: Cinda in front of class; dashboard (right) is shown on monitor in front of her

In this class, we got little feedback beyond finding, via a brief survey, that the students felt the tablets worked well for note-taking. (We heard from four students out of twelve volunteers; all had suggestions for the software, but none had any real problems with it. One student remarked, “I felt the Tablet was great for taking notes. It was highly responsive and very accurate. I was able to write just as fast as I normally would.”)

The real question is to what extent the instructor got useful information from the dashboard. Really, our idea is that the teacher would find the dashboard informative, would adjust her lecture accordingly, the entire class would find the lecture going at a more appropriate pace (for the majority of students), and students would thereby stay more engaged and learn more. The result, in other words, would be improved learning outcomes. However, it seems fanciful to try to test such a broad hypothesis, so we are concentrating on the simpler question: does the instructor *believe* the dashboard is helping her teach better?

For this, the results are – well, there really aren’t any yet. We were able to provide the dashboard for about fifteen classes, and only found a good configuration – where the dashboard was easily readable and well placed for Cinda to see it – after about the first six classes. Cinda did not appear to look at the dashboard very much, but she claimed that she looked at it more and more. (In the last class, the dashboard actually did not work, and Cinda said she felt its absence.) In any case, she wants to continue

the experiment in the fall. In retrospect, it seems obvious that an instructor would have to adjust her teaching to the dashboard, just as instructors adjust their teaching when using clickers. What I hope to see is that Cinda finds the dashboard useful enough that she will look at it more, and adjust her teaching so that it becomes more useful, and continue in this way until an optimal balance is found. For example, she might start assigning problems in class that take a few minutes to do; this is something typically done in clicker-equipped classrooms but less often in other classrooms, possibly because teachers don't like to have students working for several minutes without the teacher knowing what they're doing.

So we will continue the experiment in the spring. We now have the IRB approval, and all the systems – both technical and administrative – working well, so we should be able to get started quickly. We are still not sure, however, what exactly to measure, and how to decide if the dashboard idea “works.”

One last note: Speaking of administrative systems, this experiment is somewhat complicated to run, so I'd like to record a bit of what actually went into it. Because there was no dashboard set-up in 1404, we had to bring a monitor, and a computer to run it, to each class, along with the tablets given to students. Here is how each class ran: (1) Sometime before the class – usually a few days before – we sent a message to all the student volunteers telling them which students were assigned to use the tablets in that class. (2) Two students from the class – Simon Huynh and Han-Wen Yeh – were hired to handle the machines in each class. They went to the room where the tablets were (1129), got five tablets and a monitor, and took them to the lecture hall. Four were for students and one was the dashboard computer. They set up the latter in the front of the class. (3) They had a sign-up sheet so that each of the assigned students would sign out a tablet when they arrived, noting the number of the machine. Students would start the tablets on their own; we had no problems with this. (4) At the end of class, the participating students, following specific instructions provided at the start of the experiment, saved their notes, in both “native” Slice format and pdf. They then returned the tablets to Simon and Han-Wen, who took them back to 1129, along with the dashboard computer and display, and then mailed the pdfs to the students. The only mishaps of the semester were: (1) The export-to-pdf function failed frequently, and apparently randomly, on the student tablets; in every case, we were able to produce pdfs on our machines from the saved native Slice files, so no students lost notes. With one exception: (2) One student in one class failed to follow our instructions about saving at the end of class, and lost that day's notes. (3) The dashboard failed to work on the very last day of class; this had no effect on the students. We have no idea why this happened.

References

[BK07] Tony Bergstrom, Karrie Karahalios. Conversation Clock: Visualizing audio patterns in co-located groups. *HICSS 2007*. (Available at <http://social.cs.uiuc.edu/publications.html>.)

[SG07] Beth Simon, William Griswold, “How to get students to blog during class,” <http://www.jacobsschool.ucsd.edu/pulse/fall2007/research1.shtml>.

[WK07] Mike Woodley, Sam Kamin, "Programming Studio: A Course for Improving Programming Skills in Undergraduates." ACM Technical Symposium on Computer Science Education (SIGCSE 2007). Covington, Ky. March, 2007. (Available on the Slice pubs page, slice.cs.illinois.edu/pubs.html.)

APPENDIX: Results of survey on the use of Tablet PCs in 242 sections, Fall 2010

1. Since starting to use the Tablet PCs in studio, please note how your experience in the studio has changed. Please check one box on each line:

(a) Do you find the discussions more engaging?

Much more 2 A little more 8 Same amount 0 A little less 1 A lot less 0

(b) Do you find the discussions more efficient (i.e. more accomplished in the two hours)?

Much more 0 A little more 6 Same amount 3 A little less 2 A lot less 0

(c) Do you feel better able to contribute to the discussion?

Yes, significantly 2 Yes, a little 6 No change 3 No, a little less 0 No, much less 0

(d) Have you been better able to understand presented code?

Yes, significantly 4 Yes, a little 3 No change 4 No, a little less 0 No, much less 0

(e) Have you felt that you can present your code more effectively?

Much more 1 A little more 4 Same amount 3 A little less 2 A lot less 1

(f) During the discussions, do you usually follow the presenter or explore his or her code independently?

Usually independently 3 Sometime independently 4 Usually follow presenter 4

(g) Do you feel the ability to navigate code independently is important?

Yes, very 3 Yes, a little 8 Not very important 0 Not at all 0

(h) For this question, select whichever ways of completing the sentence you most strongly agree with, if any: The ability to ask questions and make comments in writing, instead of just orally:

allows me to not to be misunderstood. 3 allows me to ask more quickly. 4 allows me to use pictures, which often work better when discussing programming. 9 no particular advantage. 0

2. Open question: Please tell us what you like, don't like, or would like to change about the Tablet PCs in the studio, or make any comments you like on the use of the Tablets in the studio. (If you wish to elaborate, feel free to send email to Charlie or to Prof. Kamin (kamin@illinois.edu).)

Con: Needs syntax highlighting (three times); crashes occasionally; "Not so difficult to get open for everyone"; can't demo code without attaching laptop

Pro: "Good resource"; fun to use; being able to underline and point out things was helpful; nice to not need to bring laptop to class