Why come to class? – Posting Notes from Tablet PC Lectures

Abstract

When I first used a tablet PC in teaching I had colleagues who posted their notes for their students. My first reaction was, “Why would I do that? The students will not see any point in coming to my class.” Furthermore, I was concerned that my students would not learn to be good note takers, instead relying on the posted notes. In this work, we are focusing on how students used posted notes and the impact this had on student attendance, learning, and perceptions.

Introduction

In the last five years tablet PCs have become prevalent in discussions and studies of higher education pedagogy, but their usage is not ubiquitous. Tablet PCs are laptop computers that have a touch sensitive screen that responds to a stylus input. This enables the integration of material prepared before class with hand-written annotations during class. Recent advances have made tablet PCs less expensive and more reliable and thus more available in higher education classrooms. They are, however, relatively new to the classroom and the sphere of their implementation is modest. Some possible reasons for this include the learning curve for using tablet PCs effectively and the limited but quickly growing body of research supporting their effectiveness.

There has been much work at our school since 2003 studying the implementation of tablet PCs in the classroom and DyKnow Vision collaborative software. In these studies the instructor has had a tablet PC and the students have had tablet PCs, laptops with Wacom slates, or no computer during lecture. The DyKnow Vision software enabled implementation of a variety of classroom assessment techniques and electronic collaborations between students and between students and the instructor. This study focuses on instructor use of a tablet PC for lecture delivery while students only have hard paper copies of the prepared portion of the course notes.

Some other researchers have looked at the case where just the instructor uses a tablet PC. These studies investigated student expectations and reactions to tablet PCs and improving student engagement and learning. Both studies reported an active learning environment where students were regularly interacting with each other and with the instructor. Survey questions asked about student perceptions of the notes posted on the course management website with very positive feedback. The first study does not make connections to student learning and encourages future researchers to do so. The second study only mentions attendance anecdotally, but sought to tie survey results and prior performance to standardized exam scores to measure learning gains. Evidence shows that the students in the active classroom with the tablet PCs scored better on the standardized exam than students in a traditional non-tablet PC classroom. In the present study student learning, attendance and perceptions are investigated relative to student access of filled-in course notes posted on the course management software.

We hypothesize that students, in general, see class attendance as useful even when given access to filled-in notes from class. Since I post my notes using our course management software, we
are able to track when and how often students access the notes. We hypothesize, as you might expect, that there is more access just before homework is due and just before an exam. However, we also hypothesize that there is a positive correlation between students accessing the posted notes on a routine basis and course grades. That is, students who are referring to the notes on a regular basis are more likely to do better in the course.

Methods

This study was implemented in two sections of a senior mechanical engineering control systems course taught in fall of 2008. As part of the preparations for this class the learning objectives were updated for clarity and measurability. The updated learning objectives excerpted from the course policies handout are listed below.

After successful completion of this course, students will be able to:

1. **Identify** 1st and 2nd order system components with the appropriate performance measures and **construct** the Bode plots of systems described by transfer functions.
2. **Solve** for system responses to various inputs using Laplace transforms.
3. **Formulate** and **interpret** root locus plots, frequency response plots, block diagrams, and state space system representations.
4. **Analyze** and **design** control systems to achieve specified transient and steady state performance criteria using root locus, frequency response, and state space techniques.
5. **Create** and **debug** appropriate Matlab m-files, Simulink simulations, and RealTime Workshop files to evaluate control system designs and implement controllers.
6. **Work** effectively with a lab partner to complete lab assignments and **communicate** the results of their lab work effectively in the form of technical reports.

In addition to teaching with a tablet PC, the learning environment was active. There were regular cooperative quizzes (about once per week), daily in-class cooperative student exercises, and a multitude of opportunities for student-student and student-instructor interaction, such as talk-to-your-neighbor to answer a question. This is similar to the classroom environments described in the cited studies.5-6

All lectures were delivered using a tablet PC while students only had instructor provided paper copies of blank notes. Notes were prepared using PowerPoint with some equations and figures provided and mostly open white space that allowed for student work and student + instructor work. A sample of blank note slides is provided in Figure 1.
Root Locus – Controller Design

\[ R(s) + \frac{1}{s(s+4)(s+6)} Y(s) \]

Design a controller to satisfy the following performance criteria using Root Locus.

\[ t_{25\%} = 1 \text{ sec} \]

\%OS = 16%

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**Figure 1 - Excerpt of Blank Notes for Students.**

The goal was to provide the important figures and background equations so that students could focus on taking notes for the core concepts rather than scribbling down supporting details or trying to sketch tedious figure details. Students were encouraged to take their own notes since more is said or discussed in class than is written down in the instructor’s notes. After each class PDF copies of the instructor’s notes filled-in during class were posted on the course management website. Sometimes the filled-in text was from the instructor and sometimes it was from the instructor’s notes on a class discussion of a student exercise. Figure 2 includes a sample of the instructor’s filled-in notes corresponding to the blank notes in Figure 1.
Design a controller to satisfy the following performance criteria using Root Locus.

\[ t_{25\%} = 1 \text{ sec} \quad \Rightarrow \quad |\text{Reall}| = 4 \]

\[ \%\text{OS} = 16\% \quad \Rightarrow \quad \xi = 0.504 \quad \Rightarrow \quad \phi = \cos^{-1}(\xi) = 59.7^\circ \]

We use Angel course management software. Separate notes were filled-in for each section and posted on the respective sections website so student’s had a record of what was written down in their class period each day.

**Assessment**

Student performance/learning is being tracked by using exam grades and the final course grade. Three exam grades were tracked from the two exams during the quarter and the final exam. Student attendance was recorded daily by the instructor. Student perceptions were gathered through two surveys; one survey at the beginning of the term and one at the end of the term. The end-of-term survey is included in the Appendix. These surveys provided both quantitative and qualitative data. The use of the Angel course management software also allowed tracking of student access to the course webpage and elements of the course page, specifically filled-in notes, in this case. Collection of this data enabled a correlation study between what students say about their behavior and what the attendance and online note access demonstrates about their behavior. There were a total of 51 students in the two sections of this course. Of the total number of students, 24 students completed the assessment surveys.
Results and Discussion

Attendance data does not show any drop off due to posting my notes. Most students (47 out of 51) missed 0-3 class periods. The two most common reasons for absence were job interviews, common in a class of senior students, and being sick. Some students commented that the instructor said more and there was more that went on than was captured in the posted notes. This reinforces that there is something more to class than just the regurgitation of facts, solutions, or theories. Being in class and participating in class is part of the learning experience. This is especially true in an active classroom environment. Furthermore, the data does not show any significant relationship between class absences and course grades. This is depicted in Figure 3 below where individual points along the x-axis represent a single student.

![Figure 3 - Student Grades and Class Absences](image)

In Figure 3, the students are sorted in rank of overall grade, so the grade plot is monotonically decreasing. Each absence circle corresponds to the student at that rank. For example, the top ranked student in Figure 1 had 3 absences. It may also be important to note in Figure 3 that 36 out of 51 students had an 80% (B) grade or above. That means roughly 72% of the class demonstrated good mastery of the learning objectives as measured by the overall course grade.

Student access to the course website is shown chronologically in Figure 4.
Figure 4 - Day-by-day logins from first day to day of final exam. (Includes weekend days.)

In this format, it is easy to see the high demand immediately preceding homework due dates and exams. This matches our hypothesis. In this case student logins to the website were used as a proxy for student access for filled-in course notes. This is not a perfect one-to-one relationship, but as the data in Figure 4 shows, it is informative. Also, 62% of students reported that they accessed Angel when they needed to reference the filled-in notes as opposed to 20% that said they printed out hard copies.

Contrary to our hypothesis, there were no statistically significant relationships between access to filled-in course notes and student grades. One possible explanation for this is that this sample of students is from among high achievers (72% received a B or higher), so that regardless of course grade students are regularly accessing material. Another explanation might be that students who are doing well access the notes and are using them effectively while students who are struggling are also accessing the notes, but not using them effectively. That is, tracking the number of logins does not capture how effectively the students use the notes.

Two clear statistically significant correlations existed. The first correlation (mean 24.88, p = 0.019) was between number of times students accessed filled-in course notes and student confidence with learning objective 4:

4. Analyze and design control systems to achieve specified transient and steady state performance criteria using root locus, frequency response, and state space techniques.

This clearly indicates that students who accessed the filled-in notes more frequently, and therefore had more regular interaction with the course material, were more confident in applying the concepts they learned in class. To the degree that student confidence is related to persistence
and learning, this is a positive relationship. The second correlation was not related to the use of tablet PCs in the classroom. It was the correlation (mean = 2.36, p = 0.008) between final course grade and learning objective 5:

5. **Create** and **debug** appropriate Matlab m-files, Simulink simulations, and RealTime Workshop file to evaluate control system designs and implement controllers.

Matlab is a software program that is used extensively by controls engineers. In this course many activities and assignments require the use of Matlab. Two prior courses in the curriculum teach programming and numerical methods using Matlab so it is not newly introduced in this course. This is an interesting result and underscores the importance of this pre-requisite for the control systems course.

The survey results help illuminate student perceptions of the implementation of the tablet PC in this course. Two items of particular interest are depicted in Table 1.

### Table 1 - Tablet Means across the Quarter
(6 Point Rating Scale)

<table>
<thead>
<tr>
<th>Item</th>
<th>ME 406</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st Week</td>
</tr>
<tr>
<td>Tablet Interest/Enjoyment**</td>
<td>3.28</td>
</tr>
<tr>
<td>Tablet PC Distraction **</td>
<td>3.60</td>
</tr>
</tbody>
</table>

** indicates statistical significance

n = 25

Between the first week and the 10th week students’ interest/enjoyment of the instructor’s use of the tablet PC went up significantly (score range: 1 strongly agree to 6 strongly disagree). At the same time students’ perception of the tablet PC as a distraction in class went down significantly (score rage: 1 definitely to 6 definitely not). All free response comments from students on these questions were positive for the instructor use of the tablet PC. These two student comments are representative of the sentiment associated with these results of other students who filled out the survey:

“[The instructor] did an AMAZING job using the tablet PC. He integrated it very well into the course, and it made things run much smoother and efficiently. I have had other professor attempt to use the tablet, but he is by-far an outstanding instructor with PC integration.”

“In the past I have found it to be a distraction if everyone in the class has a tablet, but just the professor having one worked well.”
Additionally, several students commented that they felt instructor use of the tablet PC was not distracting, but, based on prior experiences, students and instructors using tablets was distracting. It is significant to note that in these other experiences that the students did not own their tablet PCs. Instead students used tablet PCs that remained in a dedicated classroom. This lack of familiarity may be related to their comments on distraction. In this study, the class periods were in a room without dedicated tablet PCs. Also, students brought their laptops to selected class periods to work on active exercises during class.

Student’s were overwhelmingly positive about the instructor use of the tablet PC and having access to the filled-in notes. Based on their survey comments many of them used the notes as they were intended, that is, as a supplement to their own notes and to focus attention on course concepts rather than copying diagrams or text. The following representative comments reinforce this:

“[The tablet PC notes were] easy to see, easy to read notes that could be accessed later. [Using the tablet PC] made it easy to integrate Simulink and other required programs into lectures.”

“We were able to follow along with the notes easily without wasting time drawing diagrams.”

“Posted notes had different colors on them, which helped a lot with diagrams that had several different things drawn on them.”

“Filled-in notes were a great supplement to my own notes from class. Having the instructor’s notes to compare with the steps I wrote down made the homework a lot easier to follow and complete.”

“I liked being able to review [the] professor’s notes with mine.”

The last comment in this list was made by the same student who made the last comment in the previous list. It is important to note that while these are representative of many students, not all students used the notes effectively. Using a tablet PC for instruction does not automatically engage students. This implementation was concurrent with making the classroom an active learning environment for students where they were required to participate and work on tasks.

In the beginning-of-term and end-of-term surveys, students were also asked to rate their confidence meeting the learning objectives of the course on a Likert-type scale. These results are presented in Table 2. Student confidence in achieving every learning objective decreased significantly, except for the teaming and communication objective which was equally low at the start and end of the term.
Table 2 - Means for ME 406 Student Learning Objectives
(Rating Scale: 6 point scale ranging from 1 = completely unconfident to 6 = completely confident)

<table>
<thead>
<tr>
<th>Learning Objective</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Identify 1st and 2nd order system components with the appropriate</td>
<td></td>
</tr>
<tr>
<td>performance measures and construct Bode plots of systems described by transfer</td>
<td>3.71</td>
</tr>
<tr>
<td>functions.</td>
<td>2.08</td>
</tr>
<tr>
<td>**Formulate and interpret root locus plots, frequency response plots, block</td>
<td>3.56</td>
</tr>
<tr>
<td>diagrams, and state space system representations.</td>
<td>2.20</td>
</tr>
<tr>
<td>**Solve for system responses to various inputs using Laplace transforms.</td>
<td>4.28</td>
</tr>
<tr>
<td>**Analyze and design control systems to achieve specified transient</td>
<td>4.16</td>
</tr>
<tr>
<td>and steady state performance criteria using root locus, frequency response, and</td>
<td>2.44</td>
</tr>
<tr>
<td>state space techniques.</td>
<td></td>
</tr>
<tr>
<td>**Create and debug appropriate Matlab m-files, Simulink simulations, and RealTime</td>
<td>3.00</td>
</tr>
<tr>
<td>Workshop files to evaluate control system designs and implement controllers.</td>
<td>2.36</td>
</tr>
<tr>
<td>Work effectively with a lab partner to complete lab assignments and communicate</td>
<td>1.75</td>
</tr>
<tr>
<td>the results of their lab work effectively in the form of technical reports.</td>
<td>1.58</td>
</tr>
</tbody>
</table>

Notes: ** indicates a statistically significant difference.

At first the results of Table 2 may seem discouraging. Did the instructor fail? The simple answer is no. A significant number of students demonstrated mastery of course material, which is evident in 72% of students earning a B grade or higher. These are self-reported results that depict student perceptions. Similar data showing the same trend has been gathered in many other tablet PC classrooms at Rose-Hulman. It appears that students have a pre-course over confidence in their abilities, especially in courses such as this one where students’ have seen some or some elements of the material before. In this controls course students have been introduced to some of the concepts in the prerequisites, but they have not put it together to apply it to control systems. At the end of the course it appears students have more realistic judgment regarding their abilities.

Conclusions

Student attendance for this course was not affected by the instructors’ use of the tablet PC as 47 out of 51 students missed 0 to 3 days out of 30 lecture days. This was, perhaps, due in part to the active learning environment. Predictably, students access course materials and specifically the filled-in notes much more immediately prior to turning in homework and taking exams. There were no statistically significant correlations between students accessing filled-in notes and course grades in this data set. However, there was a positive correlation between student confidence and one of the learning objectives dealing with applying course concepts. Student confidence grew as a result of more frequent access to course materials.

Bibliography


Appendix – End-of-Term Survey

1. Please rate your level of comfort using a laptop. *(Answers: Completely Comfortable (1), Mostly Comfortable (2), Slightly Comfortable (3), Slightly Uncomfortable (4), Mostly Uncomfortable (5), Completely Uncomfortable (6))*

2. Please rate your level of comfort using a tablet PC. *(Answers: Completely Comfortable (1), Mostly Comfortable (2), Slightly Comfortable (3), Slightly Uncomfortable (4), Mostly Uncomfortable (5), Completely Uncomfortable (6))*

3. Please rate your level of comfort using a Wacom slate. *(Answers: Completely Comfortable (1), Mostly Comfortable (2), Slightly Comfortable (3), Slightly Uncomfortable (4), Mostly Uncomfortable (5), Completely Uncomfortable (6))*

4. I enjoyed how my instructor used the tablet PC in class. *(Answers: Strongly Agree (1), Moderately Agree (2), Slightly Agree (3), Slightly Disagree (4), Mostly Disagree (5), Completely Disagree (6))*

5. Please explain your answer to question #4. *(Free Response)*

6. The instructor’s tablet is more of a distraction than an asset in class. *(Answers: Definitely (1), Very Probably (2), Probably (3), Possibly (4), Probably Not (5), Definitely Not (6))

7. Please explain your answer to question #6. *(Free Response)*

8. How do you most prefer to take notes during class? *(Answers: Use instructor provided notes, Supplement instructor provided notes with your own, Take all of your own notes, Not take notes at all)*

9. When do you refer to your notes outside of class (mark all that apply)? *(Answers: Doing homework, Working on Projects, Before exams/quizzes, Never)*

10. When do you refer to the course notes posted on Angel (mark all that apply)? *(Answers: Right after class, Doing homework, Working on projects, Before exams/quizzes, Never)*

11. When you reference the course notes posted on Angel do you (mark all that apply): *(Answers: Print them out, Save them for future use, Access Angel when needed, Don’t use the notes on Angel)*

12. How often did your instructor use DyKnow during lecture? *(Answers: Very Frequently, Frequently, Occasionally, Rarely, Very Rarely, Never)*

13. How often did your instructor use PowerPoint during lecture? *(Answers: Very Frequently, Frequently, Occasionally, Rarely, Very Rarely, Never)*

15. Which of the following did you use during class (mark all that apply)? (Answers: Tablet PC, Laptop, Pen and Paper, None of the Above)

Please rate your level of confidence in your current ability to complete each of the learning objectives below.

16. Identify 1st and 2nd order system components with the appropriate performance measures and construct Bode plots of systems described by transfer functions. (Answers: Completely Confident (1), Mostly Confident (2), Slightly Confident (3), Slightly Unconfident (4), Mostly Unconfident (5), Completely Unconfident (6))

17. Formulate and interpret root locus plots, frequency response plots, block diagrams, and state space system representations. (Answers: Completely Confident (1), Mostly Confident (2), Slightly Confident (3), Slightly Unconfident (4), Mostly Unconfident (5), Completely Unconfident (6))

18. Solve for system responses to various inputs using Laplace transforms. (Answers: Completely Confident (1), Mostly Confident (2), Slightly Confident (3), Slightly Unconfident (4), Mostly Unconfident (5), Completely Unconfident (6))

19. Analyze and design control systems to achieve specified transient and steady state performance criteria using root locus, frequency response, and state space techniques. (Answers: Completely Confident (1), Mostly Confident (2), Slightly Confident (3), Slightly Unconfident (4), Mostly Unconfident (5), Completely Unconfident (6))

20. Create and debug appropriate Matlab m-files, Simulink simulations, and RealTime Workshop files to evaluate control system designs and implement controllers. (Answers: Completely Confident (1), Mostly Confident (2), Slightly Confident (3), Slightly Unconfident (4), Mostly Unconfident (5), Completely Unconfident (6))

21. Work effectively with a lab partner to complete lab assignments and communicate the results of their lab work effectively in the form of technical reports. (Answers: Completely Confident (1), Mostly Confident (2), Slightly Confident (3), Slightly Unconfident (4), Mostly Unconfident (5), Completely Unconfident (6))

22. If you have missed class this quarter, what was the reason? (Answers: Sports, Tired, Left early for weekend/break, Job interview, Other)

23. If you answered “other” to item #22, please specify. (Free Response)

24. Overall, I was satisfied with my classroom learning experience using a tablet PC. (Answers: Strongly Agree (1), Moderately Agree (2), Slightly Agree (3), Slightly Disagree (4), Moderately Disagree (5), Completely Disagree (6))

25. Please provide any other comments you may have on the tablet below. (Free Response)