AC 2011-940: PROMOTING FACULTY ADOPTION OF TABLET PCS IN UPPER LEVEL ENGINEERING COURSES

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Promoting Faculty Adoption of Tablet PCs in Upper Level Engineering Courses

Abstract

The University of Louisville's J.B. Speed School of Engineering began a student Tablet PC initiative four years ago. As a result of this initiative, Speed School of Engineering classrooms now have a one to one Tablet PC deployment. Leveraging this environment to improve the teaching and learning in the classroom is the long-term goal of this and many other Tablet PC programs. Many challenges to achieving this goal exist, including: faculty adoption, infrastructure support, and student competency. Faculty members in the Department of Engineering Fundamentals have been early adopters and pioneers in using Tablet PCs in the classroom. Adoption of Tablet PC usage in upper level courses and in other departments has been mixed and slower to develop than in the entry level courses taught by the Department of Engineering Fundamentals. A similar trend has also been the case in other schools with Tablet PC programs.

Some preliminary research and anecdotal evidence indicates that simple introductory seminars are not sufficient to provide faculty with knowledge and resources to effectively use Tablet PCs in the classroom. The authors, both members of the Department of Engineering Fundamentals, developed both a two hour introductory seminar for faculty on use of Tablet PCs, and a follow up summer workshop entitled: "Tablet Faculty Learning Community" (TFLC). Learning communities can be an effective means of promoting faculty development, and the TFLC was based on the authors' experiences in a different University Faculty Learning Community. The goal for both the seminar and TFLC were simple: provide faculty with technical and pedagogical information, and then offer support for their attempts to incorporate Tablet PCs into the classroom teaching.

A major innovation developed for the seminar, and used in the workshop, was a multiple projector approach to help faculty see each of the following: (a) the instructor's Tablet PC screen with controls, (b) the classroom projected content, and (c) a sample student Tablet PC screen. As part of the TFLC, faculty participants were required to develop material for one of their courses using a Tablet PC and then present the material to the other TFLC participants in a practice classroom setting.

There were only five participants in the TFLC, including two faculty members who had not previously utilized Tablet PCs in the classroom. Participants reported the practice setting was very effective. One participant used Tablet PCs in the classroom on a limited basis during the fall semester, and another participant has expressed serious interest in using them in future classes. Another participant is not using a tablet PC during this current semester. Approaches and techniques used in the seminar and in the TFLC are described in greater detail, as well as survey results from the TFLC participants.

1. Introduction

Interest in the use of tablet PCs in the classroom increased significantly with the release of Microsoft's Tablet PC edition of Windows XP in 2002 and Hewlett-Packard's tablet grant incentive program that began in 2004 [1]. The J.B. Speed School of Engineering began its tablet PC program in 2007 when the first incoming freshman class was required to purchase tablet PCs. Entering freshman in 2008, 2009, and 2010 have also been required to purchase tablet PCs. Due to this gradual adoption processes, not all students in upper level courses have a tablet PC, though the number is increasing each year. However, the Department of Engineering Fundamentals classes ENGR 101, 102, and 201 are freshmen courses, and therefore all students in these courses have had tablet PCs since the Tablet PC program began. The Department of Engineering Fundamentals has embraced the use of tablet PCs, which, along with DyKnow, are now an integral part of all the department's engineering mathematics classes. To date, the use of tablet PCs and/or DyKnow in upper level courses in other departments has been limited.

Tablet PC survey data presented by Hieb and Ralston [2], Huettel et al. [3] and many others indicates the potential of tablet PCs to enhance the classroom experience. The positive attitude of students towards tablet PC note taking and DyKnow based lecture reported in Hieb and Ralston [2] support continued effort to encourage the use of tablet PCs (and DyKnow) in upper level courses at J.B. Speed School of Engineering should be encouraged. There are a number of challenges that may have contributed to the more limited use of tablet PCs and DyKnow in upper level engineering courses, and these are discussed in section 2. One of the challenges likely contributing to the limited adoption rate of tablet PCs and DyKnow is that faculty are not significantly familiar with tablet PCs and DyKnow. The authors, who use tablets and DyKnow in the upper level engineering mathematics courses "linear algebra for engineers" and "numerical analysis for engineers", decided to address this challenge by developing and presenting a two hour tablet PC/DyKnow seminar for faculty and a semester long tablet PC/DyKnow workshop patterned on Faculty Learning Communities [4]. Section 3 presents the development of the seminar and the workshop (Tablet Faculty Learning Community). The seminar was presented in April of 2010 and the workshop/faculty learning community was conducted over a 10 week period during the summer semester of 2010. Section 4 discusses the authors' experiences presenting the seminar and leading the workshop. Some conclusions and future direction are discussed in section 5.

2. Background Information

A tablet PC is a laptop or notebook that has a screen capable of pen based input. Interest in the potential use of tablet PCs as an educational tool began in earnest in the early 2000's. As pointed out by Joel Backon, "Tablet PCs merge the productivity improvement afforded by PC technology with the fundamental learning functions supported by the pen" [5]. By 2006, a number of universities began to experiment with tablet PCs in the classroom, including Clemson [6], DePauw, [7] and the University of Washington [8], to name a few. The release of the Tablet PC Edition of Windows XP, the HP tablet PC Grant incentive program [1], and the development and release of Classroom Presenter [9] and DyKnow [10] greatly invigorated interest in tablet PCs in the education community.

For instructors, the most natural use of tablet PCs is as a replacement for the blackboard, whiteboard, or overhead projector. The ability to annotate imported images, to easily write complex formulas and equations, and to easily create colorful and detailed drawings make tablet

PCs particularly attractive for engineering education. For students, the most natural use of tablet PCs is as a replacement for paper notebooks. The increased organizational capabilities of tablet PC based note-taking, while not revolutionary, has clear benefits. However, new and fundamentally different classroom learning opportunities arise when both instructors and students have tablets and use collaborative learning software (CLS) during class.

DyKnow [10] and Classroom Presenter [9] are the two most well know pieces of collaborative learning software. Both create a white space that is shared by the instructor and the students during class. Digital ink applied to the white space by the instructor is transmitted to the students' tablet PC and their view of the white space. DyKnow also includes a special private ink for instructors, which is discussed in section 3. In addition, students can make their own annotations that are local to their version of the white space stored on their tablet PC. The white space is organized around panels, much like PowerPoint's slides, and instructors can collect students work in real-time during class, share and annotate it with the class, or save it for grading later. Instructors may also prepare material before class, and this prepared material can be seamlessly folded into the shared white space during class.

Some specific ways tablet PCs can enhance undergraduate engineering education are:

1. Instructors face the students and do not obstruct the view of the material [11,2].
2. Complex or simple mathematical formulas and scientific notation that are difficult to enter using a keyboard are easily recorded by the instructor and/or students using a tablet PC.
3. Students' ability to replay the instructor notes captures the dynamics of thought and explanation in a way not possible with traditional methods of lecture and note-taking [12,13].
4. Tablet PCs help accommodate different learning styles, such as visual learners.
5. Using the features of a CLS, students may be actively engaged in learning during class meetings working individually or in groups to answer a specific question or solve a specific problem. Their work can also be collected and possibly discussed in real-time during class [14,3,15,8].

There are certainly some additional and more specific ways tablet PCs can enhance learning that are not mentioned above, but the list captures major benefits frequently cited in the literature.

As these and many other papers attest, the potential of tablet PCs in the classroom are enormous. However, several universities with a mandatory tablet PC requirement are experiencing limited adoption of tablet PCs beyond an initial group of early adopters. At Virginia Tech, which has had a mandatory tablet PC requirement since 2006, the Department of Engineering Education has overwhelmingly embraced the tablet PC, but the College of Engineering is discovering it to be challenging to get other departments to embrace the tablet PCs the way the Department of Engineering Education has [16]. The situation is similar at the J.B. Speed School of Engineering, with all classes taught by the Department of Engineering Fundamentals using tablet PCs and DyKnow, but other departments adopting tablet PCs in class at a slower rate.

There are many possible reasons why faculty adoption of tablet PCs in the classroom has been slow outside the initial early adopters. Usually, a faculty member will need their own tablet PC, and there may not be department funds available for the faculty to purchase another computer,

especially if they already have a new desktop or laptop. Another challenge arises in mandatory tablet PC programs where upper level courses often have one or two students without a tablet PC. These students either transferred into the engineering school, or possibly their tablet PC broke and they have not replaced it. Konthaneth et al. [16] surveyed the engineering education faculty at Virginia Tech to determine what motivated the engineering education faculty to adopt tablet PCs. Their results suggest that to successfully diffuse tablets throughout the college of engineering will require increasing faculty perception of the advantages, compatibility, and observability of tablet PCs, and at the same time reducing the complexity of tablet PC technology. In previous work Konthaneth et al. [17] developed a DyKnow training system for students and faculty. In developing this training system, Konthaneth et al. found that more and different training was needed for faculty as opposed to students. The authors' experience is similar. A brief training period, where faculty members interact as students with a presenter, demonstrating tablet PCs and DyKnow is not sufficient for faculty to then utilize a tablet PC and/or DyKnow in their class. A lack of effective tablet PC training for faculty could be contributing significantly to slow adoption of tablet PCs in schools with a tablet PC program.

What choices do faculty have then, as far as training/preparation materials are concerned? Tablet PC applications may include some training and preparation material. For example, Microsoft OneNote includes a simple getting started notebook, and Microsoft has a web site dedicated to educating users about OneNote [18]. But this kind of training does not include the teaching and learning aspects needed to maintain faculty interest. Scholarly papers that discuss other faculty's efforts and experiences can be informative about teaching and learning, but are often short on technical how-to information or are too discipline specific. DyKnow recently began offering on-line training sessions [19]. There is a fee for these and it is unclear to which audience they are intended (K-12, Higher Ed, or both). However, these training sessions may be a good blend of technical training and teaching and learning based on the titles: "Keeping Students Focused," "Enhancing Teaching and Learning with Monitor," and "Formative Assessment Strategies." All of these are good sources, and the authors' have both used them and directed faculty to them. However, every school and instance is different, so there are invariably pieces of information that are idiosyncratic to a specific school. For example, the IP address of the DyKnow Server or who to contact to request a DyKnow account. One possible approach to improve tablet PC adoption across a school, with a mandatory tablet PC requirement, is to develop and offer a more comprehensive training/preparation program for faculty that is designed to give them all the specific technical/operational skills needed to successfully use a tablet PC in one or more of their courses.

3. Development of an Instructional Tablet PC Seminar for Faculty and a Tablet PC Faculty Learning Community (FLC)

Two distinct and equally important issues were considered when developing the tablet PC training for faculty: operational issues and pedagogical issues. Operational issues are the specifics and technical details of operating or using tablet PCs during class, for example: turning on extended desktop, starting a session in DyKnow, etc. Pedagogical issues deal with the more challenging problem of incorporating tablet PCs (in novel and beneficial ways) into teaching and learning. For example, the challenge of developing a specific class activity that makes effective use of students' tablet PCs. As mentioned above, the simplest pedagogical approach to using

tablet PCs is to simply use them as a replacement for the traditional chalkboard or whiteboard. While this approach may not be innovative, it does provide a simple pedagogical path to using tablet PCs in class. For faculty who are not familiar with using/operating tablet PCs during class, this is a good starting point, allowing them to focus more attention on developing their technical prowess with tablet PCs, before attempting more advanced uses of tablet PCs. Following this line of thinking, the authors chose a two phased approach to providing tablet PC training to Speed faculty. Assuming that more elaborate uses of tablet PCs for teaching and learning required proficiency with the technology, the authors first developed a two hour training seminar focused on: Basic tablet PC operation during class, demonstrating tablet PC capabilities, and sharing best practices identified by the authors. This seminar would be followed later by a multi-session workshop, the focus of which would be to strengthen and expand tablet PC technical skills and explore pedagogical issues. Development of the seminar is discussed in section 3.1 and the workshop is discussed in section 3.2.

3.1 Tablet PC Seminar

The two hour tablet PC Seminar was designed with three main areas of focus:

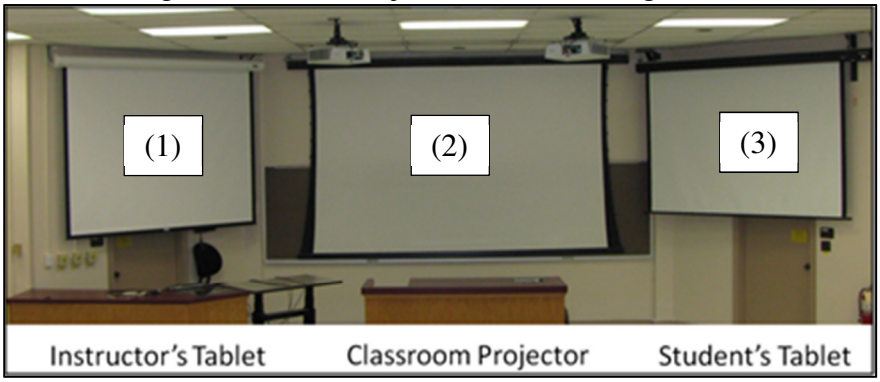
1. Tablet PC Basics;
2. Technical Aspects of Preparing Notes for Class;
3. Technical Aspects Related to Teaching a Class.

Tablet PC Basics was a ten to fifteen minute presentation defined initial items and concepts used in subsequent areas of the presentation. In addition, the basics discussed core tablet PC software: Microsoft Office, Microsoft OneNote, and DyKnow. The participants were then shown how to configure DyKnow to work at the University of Louisville; this was covered in case the faculty members were not familiar with the DyKnow set-up. The participants were also shown how to create a class in DyKnow, as well as how students find and join offered courses in DyKnow.

The second portion of the seminar was created to help faculty with outside of the classroom preparation. This section covered the inking possibilities in many different software programs: DyKnow and Microsoft PowerPoint, Excel, Word, OneNote, and Journal. In addition to an explanation of how digital ink works, a discussion of DyKnow's public versus private ink was included. It also covered how PowerPoint or DyKnow could be used to embed different items (images, web-pages, videos, etc.) into previously created lecture notes.

The final portion of the seminar involved the live demonstration of using a tablet PC in a classroom setting. This included all steps an instructor would take beginning with connecting the tablet PC to a projector, why/how to use extended desktop in Microsoft Windows based tablet PCs, starting a session in DyKnow, using prepared notes, taking a poll, and collecting student work. A major challenge the authors had to overcome was how to present this live demonstration. For participants to see only what the students would see projected on the screen was not sufficient. Instead, participants needed to see the instructor's computer, the class projector, and a student's tablet. This was achieved using a three screen approach, shown in Figure 1, where the participants were able to see three different screens simultaneously.

Figure 1: Three Projector/Screen Configuration



The three screens were used to show the participants: (1) the instructor's tablet PC desktop; (2) what would be shown on the classroom projector; and (3) what the students would see on their tablet PC desktop. This allowed the participants to easily visualize how each piece of a digital classroom presentation would appear.

3.2 Workshop: Tablet PC Faculty Learning Community (TFLC)

The goal for the workshop was to provide participants with hands on tablet PC in the classroom experience and to explore some tablet PC pedagogy. It was decided to pattern the workshop as a faculty learning community [4], or FLC, since both the authors had recently participated in another university FLC with positive results. Cox defines a faculty learning community as "a cross-disciplinary faculty ...group of six to fifteen members . . . who engage in an active, collaborative, . . . program with a curriculum about enhancing teaching and learning. [4]" The faculty who participated in the TFLC were required to have a Tablet PC, and be willing to meet for two hours per week during the summer semester. The name Tablet Faculty Learning Community (TFLC) was chosen as a name for the workshop, and it was decided to meet once a week during the summer semester (a 10 week semester). The first two meetings were designed to describe and further show specific topics from the seminar in more detail. These two meetings covered Microsoft OneNote and DyKnow, but in a smaller setting where participants could ask questions.

The authors felt that participants would learn best if they stepped through a classroom scenario. Therefore, the TFLC was organized around two homework assignments. The first assignment was for each TFLC participant to (1) to create a course in DyKnow and (2) enroll in DyKnow courses created by other participants (like students will be expected to do). At subsequent TFLC meetings, each participant would then be required to (3) set-up the tablet PC/projector; (4) start a session in DyKnow; and (5) join the sessions created by others. This homework assignment was designed to familiarize the faculty with the processes they would need to perform to teach a class using DyKnow and to understand how to help their students join the class session in DyKnow. Performing these actions in a small group setting, that is not a live classroom, would allow the faculty to practice in an environment where it would be ok if they took too much time setting up, or had trouble getting a session started.

A second homework assignment asked participants to develop some tablet PC based course materials for a class they taught. Each participant would then "test teach" these materials to

other TFLC participants during TFLC meetings. It was a requirement of the assignment that participants make use of the features of DyKnow demonstrated during the first two meetings, specifically: in-class polling; embedding a static image; embedding an interactive web-page; and set-up a group based assignment to be worked on in class. The goal of this assignment was to allow faculty to consider and try different concepts on material they were currently teaching or would be teaching in an upcoming semester. After creating the tablet PC material, it was expected that they would present it to the other participants. Following each presentation, the TFLC participant who was presenting would discuss the details of their thought process and the other participants who were "students" would provide feedback. Once again this fostered an environment that would not negatively impact learning if something went wrong during their presentation. Another useful by-product of these assignments was the ability to see how other faculty would use the technology and gain ideas on how the technology could be incorporated into their courses.

3.3 Best Practices and Lessons Learned

From a technical standpoint, both the seminar as well as the TFLC allowed opportunities to help faculty learn more about the technical possibilities and problems that exist. There are three items related to teaching with tablet PCs that were reinforced at every opportunity: extended desktop, making use of existing material, and that it is not necessary to utilize every feature made possible by tablet PCs and DyKnow to successfully incorporate tablet PCs into a course.

Extended desktop is a much underused built-in Microsoft Windows feature. It allows the presenter to have more items and controls only visible to themselves without taking up any extra presentation space. For example, the ability to have pen colors available without having to open a separate menu allows for a seamless changing of colors.

Another item reinforced is that if some form of electronic delivery is already used, these existing notes may serve as a starting point for the note preparation. The ability to transfer PowerPoint slides into DyKnow panels allows for faster implementation of basic DyKnow usage in the classroom. There are also many ways to use digital ink in programs like PowerPoint, Word, or even Excel. Using a tablet PC with inking features, even without any collaborative learning software (CLS), provides a benefit to the instructor. By using a tablet PC, the instructor is facing the class instead of ever turning their back to the class to write on a chalkboard (or whiteboard).

The last item that tablet PC use in class implementers need to be aware: Everything that can be accomplished with a piece of hardware or software doesn't need to be implemented in the first class that you teach with it. By allowing for growth utilizing a tablet PC in the classroom, faculty will be more confident by using a less complex setup.

4. Pilot Program

The Tablet PC Seminar was held twice during the spring semester 2010, the first seminar had ten attendees and the second had eleven attendees. The faculty who attended were positive afterwards, as indicated from their feedback on improving the seminar. Most felt the prepared handouts, and the demonstrations of the material in the handouts were beneficial and would

allow for an easier transition from using PowerPoint to using a tablet PC to present material to their class. The other comment that was repeated by attendees was the seminar caused them to rethink how course material could/should be taught.

The three projector approach described in section 3.1 contributed significantly to success of the seminar. Demonstrating an extended desktop would not have been possible without this approach. In addition participants were able to observe what the student interface looked like without having to join the active DyKnow session themselves, which could have been a distraction for some participants.

At the end of the seminar the faculty attendees were invited to participate in a Tablet PC Faculty Learning Community (TFLC) that would meet weekly during the upcoming ten week summer semester

The pilot program for the TFLC had five participants. The TFLC participants were surveyed at the completion of the summer semester. Every survey response said they were "very satisfied with the summer TFLC" and were glad they participated. Appendix A lists responses to three open ended questions asked in the participant survey.

5. Conclusions and Future Direction

Overall the authors felt that the seminar and workshop were successful, and plan to offer the seminar and TFLC again in the future. All of the participants acknowledged receiving some benefit from the seminar or the TFLC. After conducting the seminar twice, the authors found there to be very little additional information that should have been included and would leave the seminar largely unchanged for now. There is obviously some institutionally dependent information in the seminar, but in general the material is readily adaptable to be used by other institutions. The presentation approach, three screens with three views, was central to the success of the seminar.

Though there is no specific evidence to suggest it, the authors' opinion is that the seminar alone would not have any impact on tablet PC adoption, and is most effective when combined with the TFLC. The assignments around which the TFLC was organized achieved their objective, but the TFLC would have been much improved by a larger number of participants, between eight and twelve. With every campus having different challenges, available infrastructure, available software to faculty, and other idiosyncrasies, the TFLC would need to be customized for other institutions. One possibility the authors are considering as a means to improve participation in a future TFLC is to provide an incentive to participants in the form of a cash stipend or possibly a new tablet PC.

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Appendix A: Survey Open Ended Response Questions

	Why did you participate in the TFLC?	Did the TFLC meet your expectations?	What topics would you rate as must include in any future TFLCs?
1	To see how I can engage the students more using technology.	It generally exceeded my expectations.	Setting up classes and running them with feedback was the best part - provide more of this for LEARN BY DOING.
2	Initially primarily for collegial support.	It went far beyond, and interaction w/other participants was helpful.	Syncing and un-syncing / Polling / submitting/returning / importing from Word or PPT.
3	I wanted to learn about the DyKnow software. Since my school is a "SMART showcase" school, I may have to use SMART Suite programs rather than DyKnow. TFLC showed me what DyKnow is capable of, which will help me with the SMART software since I have a feeling that it was designed based on DyKnow.	It was wonderful! I learned more than I anticipated. I was surprised that there were only 4 professors from Louisville that participated. It was a wonderful learning opportunity. If my students had tablets, I would be so excited about learning more ways to incorporate them into my classes.	All of the topics were important - importing or creating notes, creating groups, polling students, extended desktop, etc.
4	To really learn how to use the DyKnow to the best of the abilities. Otherwise I would stick to using PowerPoint.	Yes, Jim and Jeff did not go over our heads, kept at a pace that was comfortable for all and I commend them on the excellent job they did.	I would first add in an introduction to Tablet. Most of us in the class were also new to tablet PC and were still learning how to use the pen. Everything that was covered was interesting. And even if I do not use it now, it gives me ideas on how to reorganize my class if I want to include it. For example submission of panels takes more time than expected. Planning for implementation is critical. Also a short overview on OneNote may be critical. Since students are using it, it would be beneficial that faculty know what tools the students are using.
5	Planned to use tablet to help streamline my workload in IE 370.	Yes, even though I am not able to use DyKnow as much as planned... I am now using and able to navigate thru some of the functions	Polls.