Introducing Tablet PCs: Initial Results From the Classroom

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Abstract - **Tablet PCs ("TPC"s) are drawing interest as a potential tool for improving teaching and learning in engineering education. Several schools have obtained the machines and are looking at effective uses. A recent initiative at Penn State involves thirty-one engineering faculty from eleven different disciplines. All of these faculty are trying out TPCs in their courses, and have agreed to do so for the next year and one-half. This paper reports on the initial stage of the project, in which the research question focuses on how engineering undergraduates perceive the effectiveness of the TPC as a teaching and learning tool. Over 100 students in three courses responded to an online survey related to specific uses of the TPC in their class. Responses from the students were overwhelmingly positive. This research is significant due to the increasing availability of TPCs, the lack of empirical evidence related to their effectiveness, and their potential for improving teaching and learning.**

Index Terms – Classroom Enhancement, Digital Ink, Student Perception, Tablet PC

INTRODUCTION

Although digital pen technology has been available in different forms since 1989, the latest manifestation of this tool, the Tablet PC ("TPC"), appears to hold the most promise for educators and learners [1].These are available either as slate tablets (full-time tablet configuration) or *convertibles* that allow the user to flip the screen and change from keyboard to tablet data entry and back again. Until recently, these machines were somewhat cost-prohibitive, but prices are now dropping to the level at which they my truly be considered comparable to notebook and laptop computers for educational purposes.

In general, the advantages to using a TPC are in the ability to write directly on the computer screen using a digital pen. The user's movements are converted to "digital ink", and can be used to create drawings or to enter text. In an age in which students demand more electronic support for their engineering courses, the TPC makes it easy to create digital copies of instructor-generated examples and diagrams. TPCs maintain the advantages of traditional presentation methods while mitigating the limitations. Pedagogically, applications for the Tablet PC include lecture/presentation enhancement, problem solving demonstrations, active learning support, guided brainstorming, reading, commenting, marking-up (providing feedback), and grading of student work [2].

REVIEW OF LITERATURE

The TPC has the potential to alter the educational process. According to Willis and Mierschin [3], this new technology provides unique characteristics that lend themselves to academic environments benefiting both instructors and students. A review of the current literature supports the following advantages in using a TPC.

First, digital ink enables instructors to write "on the fly" during class as one would write on a chalkboard or on a transparency [4]. This is especially meaningful for engineering courses where examples and explanations are often mathematically and graphically intensive [5]. Second, the freedom of marking-up significantly changes the way students and teachers interact [6, 7]. It facilitates bi-directional sharing of information, moving students beyond merely observing presentations to interacting with the material, the teacher, and each other. In addition, the use of TPCs supports more efficient management of information [3, 4]. Dynamic working notes can be saved in a searchable format, while lecture notes with vivid annotations become available for students' online viewing.

The merits of TPC use are accelerating the diffusion of TPCs in the classroom, which has begun to draw keen attention from educational researchers. Toto, Wharton, Cimbala, and Wise [2] explore the experiences of two engineering faculty who were using TPCs in their undergraduate courses. In this qualitative research, they describe the faculty's hardware and software choices, implementation process, and the merits of TPC applications. Schwager, Anderson, and Kerns [8] also examine the use of TPCs in an academic environment, specifically focusing on faculty perceptions. They conclude that at this point in time the greatest impact of the TPC is in their teaching, specifically in annotation of electronic teaching materials or grading student assignments, rather than in either their research or service responsibilities.

In addition to these initial studies on faculty perception, others have looked at student reaction to TPC use. Mock [4] conducted an online survey. A total of 16 students answered questions that compared, for example, TPC delivery to a traditional chalkboard approach. The feedback was strongly

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positive. Another study also reported students' reaction to TPC use, with a summarization of its deployment by instructors in computer science courses [9]. Students indicated that the use of TPCs had a positive impact on both their attention and their understanding of the material.

Berque and his colleagues [10] describe a course that was taught in an electronic classroom equipped with a network of pen-based computers. They present an overview of the instructor's use of this technology, the students' reaction, and a description of the technology that was used to support the course. In this research, 13 students were asked to state whether they prefer either a traditional classroom or the new pen-based technology and if they pay more attention when using pen-based technology. The results show that 11 students (84%) preferred the new technology, and that 9 students (69%) felt they were more attentive.

LIMITATIONS OF PRIOR RESEARCH

It is very encouraging that a fair amount of research claims benefits for TPC use with supporting evidence from the end users. However, the research to date has concentrated either on anecdotal evidence or faculty/student reaction at the *tool level*. The focus has been on investigating TPC use by small-sized intact groups, followed by quick surveys on their satisfaction. While this is an important first step, the eventual goal of TPC research must be to report on actual student performance data. The Penn State College of Engineering Tablet PC initiative is working towards this goal with a broad and systematic approach for technology integration and assessment. This paper presents initial findings from an intermediate step in the research agenda, in which data on student reaction at the *instructional level* is collected. This paper will be one in a series of reports on the practical yet detailed implications of the TPC on the teaching and learning process.

TABLET PC INITIATIVE

In the Fall of 2005, Engineering Instructional Services (EIS) at Penn State initiated two informational workshops on the Tablet PC. As a result of these sessions, thirty-one faculty who were interested in teaching with a TPC were identified and supplied either with a new TPC or the support needed to use their own machine. The underlying goal was to place TPCs in the hands of engineering faculty and see what they could do with them. Along the way, EIS would provide support and training as needed to ensure that if a faculty member decided that the TPC was not an appropriate tool for learning, it would not be because they had not been able to give it a fair trial. This paper covers an early portion of this initiative.

METHODOLOGY

This study reports on data received from students attending one electrical engineering and two mechanical engineering courses. Two faculty members were involved; the ME faculty member taught two courses. Both faculty members were teaching with TPCs, and volunteered to have their courses assessed. A total of 163 students were enrolled in these courses. The ME professor taught in both modes (TPC and Chalkboard), while the EE professor consistently used the TPC.

A instrument was developed and administered online using Penn State's course management system ("ANGEL"). The instrument is made up of 18 questions, 12 of which are quantitative, scale-based questions, and 6 of which ask for clarification of the responses. While both quantitative and qualitative items were included on the instrument, this paper focuses only on the 12 quantitative responses listed in Table I.

The instrument was administered during a two week period beginning in the 8th week of the semester (mid-term).

TABLE I
QUANTITATIVE QUESTIONS

#	Item	Type
1	Which did you prefer, the blackboard or the Tablet PC?	Choice
2	What effect did the instructor's use of the Tablet PC have on your attention to the lecture materials?	Scale
3	What effect did the instructor's use of the Tablet PC have on your understanding of the lecture materials?	Scale
	What effect did each of the following instructor activities have on your learning?	**Stem**
4	Drawing attention to points by writing on the tablet and projecting it during class.	Scale
5	Giving answers to students by writing on the tablet and projecting it during class.	Scale
6	Drawing a diagram, picture, chart, or other non-textual information on the tablet and projecting it during class.	Scale
7	Posting copies of in-class presentations on ANGEL.	Scale
8	Using different colors and highlighting while presenting a lesson with the Tablet PC.	Scale
9	Switching between multiple files / applications while presenting to the class.	Scale
10	Were there any particularly important classroom activities made possible by the use of the Tablet PC?	Yes/No
11	Did the instructor change his content or delivery style when using either the blackboard or the Tablet PC?	Yes/No
12	All other things being equal, if your instructor were teaching a course with two sections, one using the Tablet PC and the other not, which section would you choose?	Choice

DATA ANALYSIS

The overall response rate for the voluntary administration was 66% (108 of 163). There was no external incentive provided for the students who participated. Student responses for each question are reported below.

Question 1. Ninety-nine percent (99%) of the respondents indicated a preference for the use of the TPC by their instructor.

Question 2. This question allowed students to respond using a scale: 1 = "I paid much less attention", 2 = "I paid a little less attention", 3 = "There was no effect", 4 = "I paid a little more attention", 5 = "I paid much more attention". The responses are indicated in Figure 1. The mean response was 3.72, s.d. = .833. Over 62% of the students indicated that they paid more attention when the TPC was used, while five students said that they paid less attention.

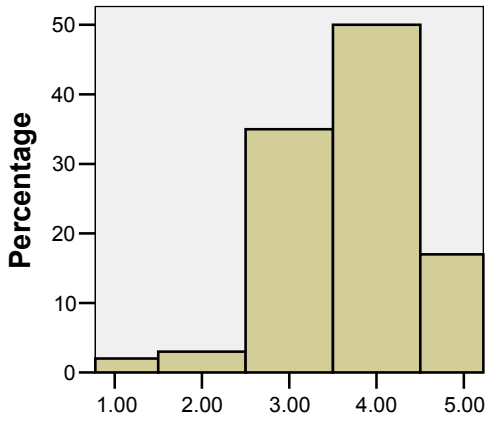

FIGURE 1.
STUDENT RESPONSES TO QUESTION 2.

Question 3. This item also used a scale. Respondents could choose from 1 ("The material was much harder to understand"), 2 ("The material was a little harder to understand"), 3 ("There was no effect"), 4 ("The material was a little easier to understand"), and 5 ("The material was much easier to understand"). The mean response was 4.0, s.d = 0.747. Figure 2 shows the distribution of responses. About 65% of the students reported that it was easier to understand the lecture when the TPC was used. Only one student said that it was a "little harder".

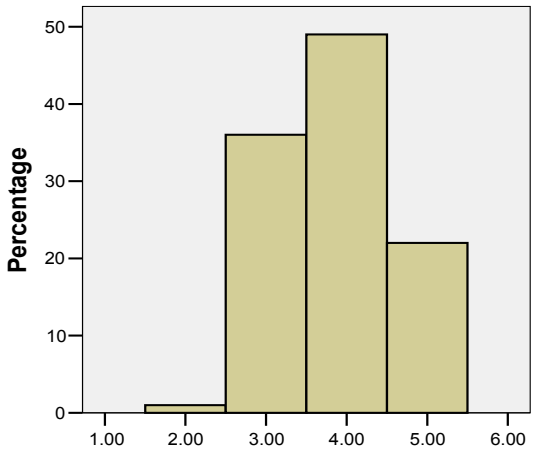

FIGURE 2.
STUDENT RESPONSES TO QUESTION 3.

Questions 4 through 9 used the same scale for student responses. The common stem was, "What effect did each of the following instructor activities have on your learning?" The response options are listed in Table II.

TABLE II.
POSSIBLE RESPONSES TO QUESTIONS 4 - 9

Value	Response
1	Instructor did not do this
2	Very negative effect
3	Slightly negative effect
4	No effect
5	Slightly positive effect
6	Very positive effect

Student responses to questions 4 through 9 are summarized in Table III, along with the percentage of students reporting slightly/very positive effects and those reporting no effect (one of the first rules when introducing technology into the classroom is to "do no harm").

TABLE III.
STUDENT RESPONSES TO QUESTIONS 4 THROUGH 9.

Question	Percent Positive	Percent Neutral
4	89%	10%
5	72%	18%
6	92%	7%
7	91%	7%
8	99%	1%
9	82%	12%

Question 10. Most students (70%) reported that there were no particularly important classroom activities made possible because of the TPC.

Question 11. Eighty-two percent (82%) of the students did not think that the instructor changed his content or delivery style when using the TPC.

Question 12. When asked if they would prefer taking a course where a TPC was used to present course material, 92% responded that they would choose to take the course where the TPC was to be used.

DISCUSSION

The instrument questions can be divided into three categories for discussion: Student Preference (1 and 12), TPC Effects on Student Learning (2-9), and TPC Effects on Instructor (10 and 11).

Clearly, the students expressed a preference for the use of the TPC in the classroom for lectures, which was the only mode of instruction investigated in this study. While this is encouraging, it may also be explained as a *novelty effect*, in which anything new is effective in holding student interest. This will have to be tested in a longitudinal manner, and should be carefully monitored. If the students' positive response to TPC use is only because of its novelty, it will not be worth the investment in time or money for faculty to adopt them.

The reported effects on student learning were overwhelmingly positive in all areas addressed by this survey. This is an important step in the research, as most survey data to date have addressed student attitudes towards the tool without focusing on the effect on student learning. The next level of research to be pursued is a direct measure of student performance related to TPC use/exposure. Students provided supporting qualitative responses to each of these questions, and the reasoning of students who responded negatively should especially be analyzed.

It is interesting to consider the students' views on how the TPC changed the classroom experience. Note that, although positive effects were reported for all of the activities listed in questions 4-9, Question 10 found most students saying that there was nothing particularly important in the way the TPC was used. This may indicate that the insertion of this particular technology into the class from the student viewpoint is non-intrusive while still having a positive impact. Moreover, the instructor did not change his content or method of delivery when the TPC was being used. This leads us to two related thoughts. First, there is a lot of room for expanding the application of TPC technology in the classroom and beyond. This paper truly addresses only a minimum application of this technology. Second, instructors who choose to try the TPC in their classrooms do not have to change their basic approach to a lecture in order to see positive effects from TPC use. This is significant in terms of likelihood for adoption of this technology by engineering faculty.

CONCLUSION

This paper presents an unreported aspect of teaching with TPCs, which is the student reaction at the instructional level. Rather than asking whether they *like* the TPC, this study asks whether the TPC is *effective* in helping them to learn. At this initial point in the research, all indicators are that the TPC is an easily-adopted technology that can have positive effects on student attention and learning. Obviously, further study and research is called for. Important next steps are to administer this instrument with a broader group of courses to determine variation caused by discipline or instructor, as well as to extend our focus in order to measure the impact of TPC use on student performance outcomes.

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