

TABLET PC USE AND IMPACT ON LEARNING IN TECHNOLOGY AND ENGINEERING CLASSROOMS: A PRELIMINARY STUDY

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1. ABSTRACT

We report our preliminary findings on the evaluation of Tablet PC technology use and its impact on learning across a variety of undergraduate and graduate classes from four technology and engineering disciplines at The Pennsylvania State University. Our assessment model is grounded in both *task-technology fit* and *social learning* theories, allowing us to evaluate the influence of Tablet PC technology characteristics, classroom task characteristics, and the role of social influence (e.g., classmates, team members) on the extent of Tablet PC use and its implications on students' learning. Preliminary results from one undergraduate engineering course and one graduate technology course show that about 65% of students in a design-oriented course found that Tablet PC use enhanced their learning experience while only 35% of students in a non-design-oriented course thought so. In both courses, nearly 50% of students found their classmates were helpful in their learning to use the Tablet PC. Preliminary regression results show that the level of task-technology fit seems to positively influence students' use of the Tablet PC and that social influence positively influences students' learning gain as the result of Tablet PC use.

2. PROBLEM STATEMENT AND CONTEXT

Tablet PCs enable users to use pen-based computing and digital ink for flexible note-taking, sketching, free hand drawing, or interactive presentation [7]. Since the first introduction of the Tablet PC interface and with recent support from industry (e.g., Microsoft Tablet PC education research programs or HP Technology for Teaching Grants initiative), many innovative studies and tools (e.g., Classroom Presenter, DyKnow) have been introduced [5]. However, two important idiosyncrasies of multi-modal Tablet PC technology—*drawing* and *collaboration*—are still not fully evaluated in teaching and learning environments. When undergraduate classes have assignments where students need to “draw” things in “collaboration” with peers and instructors, Tablet PC is an ideal medium for students to use. To assess the value of Tablet PCs in classrooms, therefore, our study incorporates three related constructs: (1) *usage of the Tablet PC*, (2) *its impact on learning*, and (3) *associated diffusion patterns across different classroom implementation environments*.

Two parallel research streams have studied technology and its associated values. One is the technology-mediated classroom literature that often evaluates the impact of technology on learning [1]. The other is the technology diffusion literature that identifies factors that drive diffusion in a social system [8]. Social factors (e.g., friends, family, colleagues, classmates) have emerged as one of the key variables that explain diffusion patterns of many technologies [9]. However, there is a lack of research that integrates these two disparate yet related perspectives to gain further insights in the impact of technology in classrooms. It is our goal to combine theories from these two research areas to assess the

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impact of Tablet PCs on learning from the collaborative drawing perspective and to understand its diffusion patterns through usage.

3. SOLUTION EMPLOYED

3.1 Theoretical Models. Although anecdotal data from our direct experiences suggest that Tablet PC technology will have a positive impact on learning and teaching, to the best of our knowledge, there have been no exhaustive studies grounded in technology acceptance and learning theories that have evaluated the extent of use and learning impact to develop insights into understanding diffusion patterns of Tablet PCs in classrooms. In the long term, we plan to develop an integrated model based on the task–technology fit theory [6] and social learning theory [4] to assess the use and learning impact of Tablet PCs. In particular, our theoretical model shown in Figure 1 evaluates the influence of Tablet PC technology characteristics, classroom task characteristics, and the role of social influence (e.g., classmates, team members) in the extent of Tablet PC use and implications on students’ learning. We will also derive diffusion patterns of Tablet PCs by evaluating actual usage and the role of social influence.

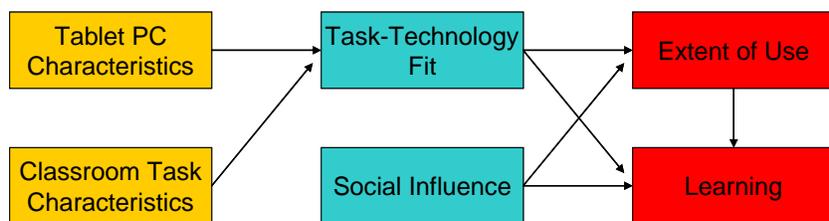


Figure 1: Theoretical Model to Evaluate Use of Tablet PCs and Impacts on Learning.

3.2 Evaluation Facets. To test the theoretical model, we argue that the study must include multiple evaluation facets. We first present our overall plan for the evaluation facets and then discuss the preliminary evaluation performed in two courses during Fall 2007.

- *Disciplines:* Five courses (introductory undergraduate through graduate levels) from four technology and engineering disciplines—*Architectural Engineering (AE)*, *Engineering Design (EDSGN)*, *Mechanical Engineering (ME)*, and *Information Sciences and Technology (IST)* — are participating in the study, extending the scope of the study by Anderson *et al.*, [3], which is limited to only the Computer Science curriculum.
- *Tablet PC Use:* The pedagogical design of these courses allows us to test four different applications of Tablet PC use in the classroom: (1) *teacher-only* (i.e., only the teacher has a tablet), (2) *teacher–team* (i.e., teacher and team leaders have a tablet), (3) *teacher–students-in-and-out-of-class* (i.e., all class participants have a tablet to use both inside and outside the classroom), and (4) *teacher–students-in-class-only* (i.e., students have a tablet to use only in the classroom).
- *Tools:* Surveys and focus groups are used to gather information from all participants.
- *Analysis:* Two analyses are being conducted: (1) *cross-sectional* and (2) *longitudinal analysis* [2] of educational impact and diffusion of Tablet PCs on individual classes and across all classes.

Table 1 lists the five courses that are being studied.

4. EVALUATION

4.1 Set-Up. In Fall 2007, we investigated the student use of the Tablet PC in two courses, EDSGN 497D and IST 511, in the engineering and technology disciplines: Engineering Design (EDSGN) and Information Sciences and Technology (IST). Table 1 provides more detailed information of these two courses.

DEPT.	COURSE TITLE	OFFERED	ENROLL.	LEVEL	TABLET PC USE
EDSGN	Innovative Integrated Design	Fall 2007	20	junior/senior	teacher–students-in-and-out-of-class
IST	Information Management: Information and Technology	Fall 2007	23	graduate	teacher–team
IST	Organization of Data	Spring 2008	68	freshman/sophomore	teacher-only
ME	Product Dissection	Spring 2008	42	freshman/sophomore/ junior/senior	teacher–students-in-and-out-of-class
AE	Virtual Facility Prototyping	Spring 2008	18	graduate	teacher–students-in-class only

Table 1: Technology and Engineering Classrooms to Use Tablet PCs.²

In EDSGN 497D Innovative Integrated Design, students learned about innovative product and system design in multidisciplinary contexts including non-engineering disciplines. This was an undergraduate course with 20 students. Throughout the course, students worked in teams on a semester-long client-based design project. Each student was given a Tablet PC for use in this course both inside and outside the classroom. Students were encouraged to use the Tablet PC for generating and drawing conceptual ideas, working in teams, taking notes, and any other tasks that they saw fit. Students often had group project meetings during their class time. MS OneNote, MS PowerPoint, MS Word, and ArtRage (a painting application) were the main applications that students used the pen with.

IST 511 Information Management: Information and Technology is an introductory graduate course that teaches theoretical, computational, and practical issues involved in managing information and knowledge from IT perspective. There were 23 students in the course. The course’s main objective is to introduce students various IT techniques and tools so that they can understand and apply them to real applications and problems. The format of the class included an instructor presentation followed by a class discussion on the lectured topic and one to two student presentations followed by a class discussion. Students also worked on three group projects during the semester. Project work involved design, programming, documentation, and presentation. Each student team was given a Tablet PC to use in and outside of class. Students in a team took turns keeping the Tablet PC with them. Students were encouraged to use the Tablet PC for drawing conceptual ideas, working in teams, and for any other tasks they saw fit. MS PowerPoint, MS OneNote, and MS Word were the main applications that students used the pen with.

4.2 Training and Data Collection. Students were provided with two types of training: (1) basic training and (2) course-specific training. Basic training introduced students to basic functionalities of the Tablet PC such as handwriting recognition and the use of the tablet pen to write and draw. Course-specific training introduced students to more in-depth use of certain Tablet PC software to carry out course-specific tasks as well as how students could use the Tablet PC meaningfully. After the basic training, students filled out the first user reaction survey. The first user reaction survey asked students about their experiences with ink-based technologies, their attitude toward new technology, affect towards using the Tablet PC, anxiety associated with Tablet PC use, effort expectancy in using the Tablet PC, and their intention of using the Tablet PC. After the course-specific Tablet PC training, students filled out the second user reaction survey. The second reaction survey asked students questions related to affect towards using the Tablet PC, anxiety associated with Tablet PC use, effort expectancy in using the Tablet PC, facilitating conditions for using the Tablet PC, and their intention of use. In the middle of the semester, students filled out a long survey and participated in a focus group. At the end of the semester, students filled out the same long survey again and participated in another focus group. The long survey asked students questions related to Tablet PC characteristics (i.e., the Tablet PC’s usefulness in

² As a preliminary study, this article presents results from only two classes, offered in Fall 2007. Data from courses offered in Spring 2008 are currently being processed and analyzed.

performing certain tasks), characteristics of the tasks in the course, task–technology fit, social influence in student use of the Tablet PC, student learning (as a result of Tablet PC use), and the extent to which students used the Tablet PC.

4.3 Descriptive Results. We first looked at the descriptive statistics from a question related to learning (“I find my Tablet PC use enhanced my learning experience”) and a question related to social influence (“My classmates were helpful for my learning to use the Tablet PC and its applications”). Table 2 shows how students in the two courses answered these two questions. From these statistics, we can see that close to 65% of students in EDSGN 497D and 35% of students in IST 511 agreed that their Tablet PC use enhanced their learning experience. In addition, about 47% of students in each of the two courses found that their classmates were helpful in their learning to use Tablet PCs.

ITEM	COURSE	PERCENTAGE OF STUDENTS				
		STRONGLY DISAGREE	DISAGREE	UNDECIDED	AGREE	STRONGLY AGREE
I find my Tablet PC use enhanced my learning experience.	EDSGN 497D	0%	5.88%	29.41%	64.71%	0%
	IST 511	5%	40%	20%	35%	0%
My classmates were helpful for my learning to use the Tablet PC and its applications.	EDSGN 497D	11.76%	11.76%	29.41%	47.06%	0%
	IST 511	5.26%	15.79%	31.58%	47.37%	0%

Note: Data was collected from 17 students in EDSGN 497D and 20 students from IST 511

Table 2: Students’ Perceptions towards the Influence of Tablet PCs on Learning

Table 3 showed the mean scores (on a 5-point scale) of the usefulness of the Tablet PC for certain tasks. Although the average scores are higher from the engineering course, students from both courses agreed that Tablet PCs are most useful in sketching diagrams, graphs, and maps.

EDSGN 497D	USEFUL TASKS FOR EDSGN 497D	IST 511	USEFUL TASKS FOR IST 511
3.71	Sketching (freehand) sketches, diagram, graphs, and maps	2.85	Sketching (freehand) sketches, diagram, graphs, and maps
3.18	Working on class assignments	2.60	Taking notes during discussions, meetings
3.18	Web surfing	2.55	Using pen to write or draw ideas during presentation in your group or in front of class
3.00	Explaining ideas to others using a Tablet PC	2.55	Sketching collaboratively with other students on one Tablet PC
3.00	Annotating documents or images	2.55	Taking notes in class

Note: The data was collected on a 5-point Likert type scale: 1 = Not Useful At All, 2 = A Little Useful, 3 = Somewhat Useful, 4 = Useful, and 5 = Very Useful

Table 3: Tasks that the Tablet PC is Most Useful for in EDSGN 497D and IST 511.

4.4 Regression Results. We ran preliminary regression analysis with data collected in EDSGN 497D. The research questions that guided our analysis are part of the research model: (1) *Do Task–Technology Fit and Social Influence predict Extent of Use?* and (2) *Do Task–Technology Fit, Social Influence, and Extent of Use predict Student Learning (as a result of Tablet PC use)?*

Results showed that Task–Technology Fit seems to influence Extent of Use (the regression coefficient is weakly significant, $p < 0.10$, 2-tailed t test) (see Table 4). This suggests the importance of designing classroom tasks that take advantage of unique features of Tablet PCs to motivate students to use Tablet PCs and recognize their values. Social Influence influences students’ learning gain as the result of Tablet PC use (the regression coefficient is strongly significant, $p < 0.01$ level) (See Table 4).

INDEPENDENT VARIABLE	DEPENDENT VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T-STAT
Task–Technology Fit	Extent of Use	0.51	0.29	1.77*
Social Influence	Learning	1.18	0.24	4.89**

Note: * = $p < 0.10$, ** = $p < 0.01$

Table 4: Regression of Extent of Use on Task Technology Fit.

4.5 Focus Group Results. Results from focus groups with students in these two classes suggest that the following questions should be considered when implementing student use of the Tablet PC in the classroom:

- Did instructors redesign the class materials to take advantage of unique Tablet PC features?
- Are students allowed to take Tablet PCs with them outside of class?
- Are Tablet PCs a primary or a secondary computer for students?
- Are proper maintenance program and infrastructure support such as reliable network connections provided?

5. CONCLUSION

This research develops an integrated theoretical perspective to evaluate the influence of task–technology fit and social influence on the extent of Tablet PC use and learning. The preliminary results reported here provide empirical evidence to suggest that task–technology fit is important to the extent of Tablet PC use in classrooms. A large number of students believe that Tablet PC use enhances their learning experience and their classmates are helpful resources in their learning to use Tablet PCs.

6. ACKNOWLEDGEMENT

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