Acceptance of Tablet PC Technology by Engineering Faculty

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Abstract - This paper considers the results of a two-year project in which Tablet PCs were given to engineering faculty at the Pennsylvania State University. During Phase 1, 34 faculty members received a Tablet PC for use in the classroom. Due to the success of this implementation and demand by other faculty, the project was expanded in the following year to include an additional 30 faculty members in the College of Engineering. During both phases of the project, the participants were asked to complete various assessment tools including scales measuring teaching efficacy, computer skills efficacy, and technology acceptance. A sample of the faculty members participated in interviews intended to gather additional information on their perceptions of the Tablet PC and its benefit in the classroom environment. This paper provides results of the project assessment and its relation to the literature on the diffusion of innovation and the Technology Acceptance Model. Implications of the assessment will be discussed that may be helpful to those who are interested in implementing a similar program for engineering faculty.

Index Terms – Tablet PC, diffusion of innovation, technology acceptance, communities of inquiry

BACKGROUND

Any technology for teaching has advantages and disadvantages. In engineering classrooms, lecture-based instruction using chalkboards, or whiteboards, has been a staple delivery method. But these traditional presentation technologies have specific limitations. Using a chalkboard requires the instructor to turn away from students for extended periods of time resulting in adverse instructional effects. For example, the instructor can miss student reactions and questions, and inadvertently block students’ view of the board and lesson content. In addition, students often copy the board verbatim, taking up valuable class time. The Tablet PC can leverage the advantages of “chalk and talk” delivery and mitigate the disadvantages. When using Tablet PCs, instructors no longer need to turn their backs on students while problem solving and diagramming on the board. They can face front, be heard more clearly, see students’ reactions, and answer student questions while writing. Students’ view of content is less likely to be blocked by the instructor because the instructor no longer needs to stand in front of the ‘board’ to write on it. Additionally, class notes can be saved in digital format and posted online for later use by the students.

In spite of obvious advantages over traditional methods, any new instructional tool will engender resistance to its implementation. This resistance can be understood in several distinct ways. First, it is important to understand this resistance through the lens of diffusion of innovation because we are considering how the use of the Tablet PC has been adopted and disseminated by the faculty in engineering. Diffusion is the process by which an innovation is communicated through certain channels over time among members of a social system [1]. Second, we need to consider the nature of the innovation. We need to examine how users have come to accept and use this innovation or technology. The Technology Acceptance Model (TAM) postulates that perceived usefulness and ease of use of a technology determine an individual’s intention to use that technology. The TAM model offers a framework to consider the factors involved with how and when faculty use the technology [2-4]. We employed the TAM framework and theories of diffusion of innovation in order to understand the acceptance of the Tablet PC in the College of Engineering at The Pennsylvania State University.

The Tablet PC Initiative and its Context

The Tablet PC Initiative evolved from two informational workshops on the use of Tablet PCs in teaching, which were conducted early in 2005 by the Leonhard Center for the Enhancement of Engineering Education at The Pennsylvania State University. These informational workshops spurred interest in the technology. The Leonhard Center, in conjunction with the university’s Education Technology Services, was able to support and pilot the use of three Tablet PCs with interested faculty from three different engineering departments. The Leonhard Center then sponsored a lunch where the participating faculty were asked to report back on their experiences with the Tablet PCs. Faculty interest was so strong that the Leonhard Center developed a research agenda and solicited short proposals from interested faculty members asking them to submit their ideas for how they might incorporate a Tablet PC into their own classroom. By January 2006, 34 faculty representing 12 departments became involved with the Tablet PC Initiative constituting Phase 1. As this fledgling community of users integrated Tablet PCs into their teaching and reported back to the community at large, more faculty members became interested and wanted to be involved with the project. In the
2007-08 academic year, another 30 faculty joined Phase 2 of the initiative. Currently we have 64 faculty members representing all departments within the college involved in the project. It is important to note that the Phase 2 faculty members were not required to submit proposals on the use of their Tablet PCs; they simply had to indicate their interest in obtaining one for classroom use.

The overarching drive behind this initiative was to identify and support a key change, in this case introducing Tablet PCs into the classroom, which would in turn contribute to the enhancement of teaching and learning in the College of Engineering. To do this effectively, we monitored our progress by assessing the effectiveness of the innovations. Over the course of this project we have documented various aspects of this initiative. At the outset we documented our first steps and looked “One Step Beyond: Lecturing with a Tablet PC” [5]. More recently we considered “Supporting Innovation: The Diffusion and Adoption of Tablet PC’s in the College of Engineering” [6].

According to diffusion of innovation theory, participating faculty members within both phases would be comprised of what Roger’s calls innovators and early adopters. Innovators are those forward-thinking individuals who help motivate change. Early adopters are avant-garde individuals who are opinion leaders willing to carefully test out new ideas. Based on Roger’s innovation of adoption curve, innovators and early adopters would represent approximately 16% of the overall faculty community. Interestingly, 64 of approximately 400 teaching faculty in the college are involved presently in the initiative – or roughly 16%.

As our group has progressed from pilot through various phases, we have witnessed this small group of faculty evolve over time. Evidence of changes in the group have been documented. For example, initially faculty members would e-mail the e-learning support specialist with questions and inquiries about the use of the Tablet PC. Now, they have formed an online community where e-mail can be exchanged directly with other members of the community, information and documents are communally housed, and discussion forums serve as platforms of interactivity for shared practice. Essentially, we are witnessing the evolution of a community of practice. During this time, the faculty members have worked collaboratively and have formulated a sense of direction and purpose related to using the Tablet PCs for teaching. Additionally, they have been interested enough to share their experiences and knowledge with one another. (For a detailed overview of the concept of communities of practice, see Etienne Wenger’s “Communities of Practice: A Brief Introduction” [7])

This investigation discussed in this paper focuses on the similarities and differences among the participants in Phase 1 and Phase 2 of the Tablet PC initiative using various measures. We consider the Phase 1 individuals to be the innovators, those individuals who selected to pilot the Tablet PC in the College without having other individuals who could serve as models. The Phase 2 faculty members are considered early adopters, those individuals who were willing to try something new, but who had been witness to the success of the first phase. This research project examines the similarities and differences between the faculty members who we consider to be innovators and early adopters. Specifically, our questions of investigation are: 1) What are the differences in demographics between participants in Phase 1 and Phase 2?, 2) What are the differences in the described use of the Tablet PC between Phase 1 and Phase 2 users?, and 3) What are the differences in teaching and computer efficacy between participants in Phase 1 and Phase 2?

METHODS

Throughout both phases of the initiative, we collected qualitative and quantitative data from the faculty. Quantitative data in the form of surveys and questionnaires was frequently collected throughout the project. In addition to the quantitative data, individual interviews and focus groups were conducted to understand participants’ views regarding Tablet PC use in their classroom. This paper focuses primarily on the results of the quantitative survey and questionnaire data collected from the faculty.

To consider Research Question 1, we compared and contrasted various participant demographic characteristics. Demographic data was collected from participants when they initially joined the project. Phase 1 demographic data was collected January 2006; Phase 2 demographic data was collected in June 2007. Specific demographic data examined in this study included gender, years of teaching experience, and department.

In considering Research Question 2, we examined the construct of technology acceptance. This is set of factors or variables posited in the Technology Acceptance Model. This model describes how users come to accept and use a technology, based on the cognitive and affective determinants of computer acceptance [3]. These are “perceived ease of use” and “perceived usefulness,” which are the foundational factors that influence computer acceptance behavior. Perceived ease of use is defined as “the degree to which the user expects the target system to be free of effort” [4]. Perceived usefulness is defined as the user’s perception of the “subjective probability that using a specific application system will increase his or her job performance within an organizational context” [4]. These two measures influence an individual’s decision about how that individual intends to use a specific technology and subsequently when, if ever, that individual will use the technology. In this study, three complete subscales from the TAM model, perceived ease of use, perceived usefulness, and intention to use, were adopted to examine the degree of acceptance of Tablet PCs by the engineering faculty. The reliability and validity of these subscales have been documented by Davis [3-4].

Table 1 displays information on the variables and measurement instruments used in this study. The perceived ease of use subscale consisted of four items, which asked the faculty members to rate their perceptions on how easy they
fled they it would be to use the Tablet PC. For example, one item stated, “I find it easy to get the Tablet PC to do what I want to do.” The perceived usefulness subscale consisted of six items that asked the participants to rate how useful they felt the Tablet PC would be for teaching, for other aspects of their job, and for increasing efficiency and productivity. For example, one item stated, “Using the Tablet PC enhances my teaching effectiveness.” For these two subscales, average item scores were calculated for each faculty member. These scores were then compared between Phases 1 and 2. The final subscale, intention to use, asked the faculty members to rate whether they planned to use the Tablet PC for teaching, other work-related tasks, and personal use. These three items were not averaged, but rather were analyzed individually. For all subscales, the faculty rated the items on a 5-point Likert-type scale, with 1 being “Strongly Disagree” and 5 being “Strongly Agree.” In addition to these three subscales, the participants were asked to describe their previous experiences with the Tablet PC and other instructional media.

Finally, to address Research Question 3, we used both teaching and computer efficacy as two critical factors influencing the acceptance of new technology. Efficacy is generally defined as an individual’s own belief about his or her capabilities to produce an effect or bring about a desired result [8]. Specifically, teaching efficacy is an individual’s judgment about his or her capability to influence student engagement and learning, even among those students who may be difficult or unmotivated [9, 10]. Computer efficacy, on the other hand, refers to a person’s perceptions of and capabilities for applying computer technology in the accomplishment of a task [11].

In this study, teaching efficacy measured participants’ self-efficacy on student engagement, instructional strategy use, and classroom management. The Teachers’ Sense of Efficacy Scale (short form), developed and validated by Tschannen-Moran and Woolfolk Hoy, was used [10]. Teaching efficacy was measured by a total of 11 items across three subscales: student engagement, instructional strategy, and classroom management (See Table 1). These items asked the faculty members to rate their perceived sense of control to influence certain aspects of their courses. An example of an item from the student engagement subscale asked the faculty, “How much can you do to motivate students who show low interest in academic work?” An example of an item from the instructional strategy subscale asked the faculty, “To what extent can you provide an alternate explanation or example when students are confused?” Finally, an example of an item from the classroom management subscale asked faculty, “How much can you do to calm a student who is disruptive or noisy?” The anchors for these subscales were also from 1 to 5, with 1 being “Not at all” to 5 being “A great deal.”

Computer efficacy measured participants’ efficacy on computers in general and Tablet PC. This instrument was newly developed for this study based on the definition of computer efficacy by Campeau and Higgins [11]. Computer efficacy was measured by four items on two subscales: efficacy for the computer in general and efficacy for the Tablet PC. An example item from this scale is the following: “I feel comfortable using a computer in general.” Once again these subscales used a 5-point Likert-type format, with 1 being “Strongly Disagree” and 5 being “Strongly Agree.”

Satisfactory reliability was found for the scales using the data collected in this study, as demonstrated by the Cronbach’s alphas presented in Table 1.

Table 1: Variables and Measurement Instruments

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sub-constructs</th>
<th># of items</th>
<th>Reliability (α)</th>
<th>Scales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Acceptance</td>
<td>Perceived ease of use</td>
<td>4</td>
<td>.919</td>
<td>Likert</td>
</tr>
<tr>
<td></td>
<td>Perceived usefulness</td>
<td>6</td>
<td>.733</td>
<td>(1-lowest, 5-highest)</td>
</tr>
<tr>
<td></td>
<td>Intention to use</td>
<td>3</td>
<td>.519</td>
<td></td>
</tr>
<tr>
<td>Teaching Efficacy</td>
<td>Student Engagement</td>
<td>3</td>
<td>.758</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instructional Strategy</td>
<td>4</td>
<td>.793</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classroom Management</td>
<td>4</td>
<td>.747</td>
<td></td>
</tr>
<tr>
<td>Computer Efficacy</td>
<td>Computer in general</td>
<td>2</td>
<td>.856</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tablet PC</td>
<td>2</td>
<td>.952</td>
<td></td>
</tr>
</tbody>
</table>

The scales were distributed to participants in either an online or paper and pencil format, depending on participant preference. For all surveys, data was collected at similar times during the academic year throughout each phase of the project. Both the efficacy and technology acceptance scales were administered to participants during their second semester of Tablet PC use. This consistent timing of survey administration helped to ensure that participants had equal opportunity to become familiar with the new technology before they responded to the survey.

RESULTS

Research Question 1 examined the differences in demographics between participants in Phase 1 and Phase 2. Table 2 provides an overview of the collected demographic information. Overall, participant demographics across both phases are quite similar. The representation of each gender is fairly consistent with males comprising over 75% of the group and women comprising just less than 25% of the group. All departments in the College of Engineering were represented by faculty in the project. Teaching experience between the groups was not found to be statistically different (r=-1.222, p=0.227), which could be due to large variance in the number of years teaching by faculty within both groups.
Research Question 2 considered the similarities and differences in the described use of the Tablet PC between Phase 1 and Phase 2 users.

Previous experiences of faculty regarding Tablet PCs and the use of other instructional media are depicted in Figure 1. In Phase 1, 8 of 34 of the faculty members had no previous experience with Tablet PCs, while 12 of 30 of those in Phase 2 had no prior experience with Tablet PCs. Regarding the use of instructional media, Phase 1 participants noted PowerPoint as the most frequently used media followed by use of the board, while Phase 2 participants indicated the reverse. Phase 2 participants noted PowerPoint as the most frequently used media.

Table 3 displays the descriptive statistics for the scales in this study. Table 4 displays the results of t-tests, which were performed in order to examine the differences between the faculty of Phase 1 and Phase 2 on the various scales.

Regarding technology acceptance constructs, using a 2-tailed-t-test, Phase 1 participants had significantly higher scores on the perceived ease of use (t=2.867, p=0.006), perceived usefulness (t=2.909, p=0.005), and the intention to use the Tablet PC for teaching purposes (t=2.008, p=0.050). No significant differences were found for intention to use the Tablet PC for other work or for personal use.

Qualitative data from the interviews reflects and supports these same trends mentioned above. Evidence from interviews indicated that faculty in Phase 2 seemed less engaged in participating in activities sponsored by the support staff at the Leonhard Center developed with the purpose of encouraging Tablet PC use.

Research Question 3 considered the differences in teaching efficacy between participants in Phase 1 and participants in Phase 2. Again, the descriptive statistics and the t-test results are displayed in Tables 3 and 4.

Faculty for both Phase 1 and Phase 2 rated their overall teaching efficacy quite highly. On the Teaching Efficacy subscale, which included engagement, instructional strategies, and management, high overall means for both groups indicates that both have quite a bit of confidence in their teaching efficacy. No statistically significant difference was found between the two groups of faculty on the overall teaching efficacy.
scale mean. Analysis of the subscales also did not yield statistically significant differences between the two phases.

Both participant groups tended to strongly agree with items measuring their computer efficacy. While there was no significant difference in efficacy toward the computer in general, faculty members in Phase 1 had a significantly higher mean score for their perceived efficacy related to the Tablet PC (t=2.767, p=0.008).

**DISCUSSION**

Across both phases of the project, the faculty in the Tablet PC Initiative are spearheading the college’s adoption of the technology. The faculty members are applying the technology in interesting and novel ways in the classroom and seem truly interested in how the technology can further be exploited. Several faculty members have emerged as being true innovators as they have used the Tablet PCs in their classes in unanticipated ways. Their individual struggles and successes have served to embolden other faculty who are willing to experiment and test the technology as a teaching tool in the classroom.

While individuals from both phases have exhibited innovative uses of the Tablet PC, this study shows that the two groups have some differences. The results indicate that individuals in Phase 1 found the Tablet PC to be more useful and easier to use as compared to individuals in Phase 2. Not surprisingly, the individuals in Phase 2 also had lower perceived efficacy towards using the Tablet PC as compared to their predecessors in Phase 1. While the Phase 2 faculty members may still be considered early adopters, they have more hesitation and less confidence in their acceptance of new technology. The individuals who participated in Phase 1 may naturally be more innovative and open to the technology than the participants in Phase 2.

Individual interviews with faculty members supported this finding. Regarding efficacy, 90% of faculty in Phase 1 indicated that they had no problem with learning how to use a Tablet PC, and felt confident in using one, as exemplified by following comment: “It was so easy to learn. I mean, I didn’t even try to learn how to use it. I just played with it,” Another faulty member offered: “I tried the Tutorial installed on the machine… for about 5 or 10 minutes. The only difference [from a laptop] is handwriting. What’s [the] big deal?” On the other hand, more than 50% of faculty who were interviewed from phase 2 expressed concerns that it would take some time to get used to using the Tablet PC. One individual stated: “I need … some time to get used to it. I am not used to using a computer or a laptop without a mouse. With the Tablet PC, you don’t use the mouse but you use the pen. Maybe the idea is that it’s intuitive to use the pen, but it comes down to [practice], because [I am] so used to [a mouse] in the computer environment, I need time to get used to it.” Another faculty member from Phase 2 noted: “I get better at it. I need to practice more, I am hoping for [the] spring semester to … [develop] … Power Point slides…”

Accordingly, faculty in Phase 1 and Phase 2 responded differently in terms of innovative use of Tablet PCs. Some of the faculty in Phase 1 mentioned a variety of ways to use the Tablet PC in the classroom such as the following: “I randomly select a [student] group and give them my Tablet PC, saying you will present. And then we all talk about how to correct mistakes if there’s any. Now they want to present.” Another faculty member noted, “One of the methods that would get students out of the passive listener mode is involving them in problem solving. I try to incorporate that into the classroom. I work a lot of problems in the class and I have students do them with me. And [the] Tablet PC helps me do that.” However, some of the responses from Phase 2 were different from the ones from Phase 1, as exemplified by the following comment: “I am just a basic user; I am not a professional user of the Tablet PC. I think there are lots of functions I don’t know but may not be need at this time.”

Another significant finding in the study is that the faculty members in Phase 1 had a greater intention to use the Tablet PC in the classroom for teaching purposes. This may be related to the manner in which the faculty members were recruited for each of the phases. As mentioned above, the individuals who participated in Phase 1 were asked to write a very short proposal about how they intended to use the Tablet PC in the classroom. The individuals in Phase 2 were not asked to do this, but needed only to express interest in participating in the initiative in order to receive a Tablet PC. This difference at the outset of the two phases may have influenced whether or not the participants had considered using the Tablet PC for teaching purposes, even though this purpose was repeatedly conveyed in the Leonhard Center’s description of the project.

These results have implications for other faculty support units interested in developing similar initiatives. Considering how we recruited for the project, we realize now that requiring the faculty members to write even a short proposal about how they planned to use the technology to enhance student learning may have had an impact about who self-selected to participate and at what level they used the Tablet PC in the classroom. Although we cannot say with certainty, we feel that the proposal requirement encouraged those faculty members with stronger interest and greater willingness to use the Tablet PC to apply during Phase 1.

Another implication for faculty support units involves the type of support provided to the participants. Although the Phase 1 faculty had fewer role models who were using the Tablet PC in the college, they had less hesitation with learning the technology. Phase 2 faculty members were aware of other individuals, perhaps in their own departments, who were using the Tablet PC successfully in their own teaching. However, they expressed more hesitation and less confidence with the technology. While similar types of support, in the form of monthly workshops, luncheons, and individual consultations, were offered to each group, Phase 1 individuals seemed to be more open and ready to use the technology. The Phase 2 individuals, who although appeared to need more support in learning the technology, also seemed less participative and less willing to learn. We
are still considering how to best implement necessary support for future phases that may be developed.

An interesting future direction of this study concerns the notion of a community of practice, which is defined as a group of individuals participating in a communal activity who are experiencing and continuously creating a shared identity through engaging in and contributing to the practice of a community [12]. In our initiative, the shared activity is the use of the Tablet PC to enhance teaching practice in the classroom. The larger community, comprised of pivotal members of the Phase 1 and 2 groups, has evolved over time. Interest in Tablet PC use remains high as various faculty members continuously inquire about how they can push the limits of this technology and expand on the innovative uses in the classroom. For example, several faculty members in both groups are entertaining the idea of how they might be able to get Tablet PCs into the hands of their students. Various faculty members have accepted invitations to speak about their own implementation of the Tablet PC into their classes and have been more than willing to share those ideas with fellow users. Individuals have also discovered and shared pertinent tools and software related to the Tablet PC and its inking capabilities, further evidence of a community of practice. Given the results and implications of this investigation, it may be informative to further explore the notion of community of practice within the Tablet PC group, including the factors that impact the group’s identity and evolution, the influences of the group’s development, and the process for how new knowledge related to the Tablet PC is discovered and disseminated.

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REFERENCES


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