The Perceived Impact of a Mandatory Tablet Personal Computer (TPC) Program on Underrepresented Students

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Abstract **- An increasing number of universities are integrating a Laptop or Tablet personal computer program into their curriculum. While the addition of such programs attempts to produce students who are more engaged and receive better grades, few institutions examine the effect of such mandatory programs on the students. Since Laptop PCs can cost nearly $1000 less than Tablet PCs, it is difficult to justify this increase in cost for students who are already struggling to find funding for their tuition, books, and housing. Though many students are comfortable with the use of computers, students from underrepresented populations may not have the same basic foundation of computer usage during their K-12 education. In this study, a questionnaire was distributed amongst the students, and a subset of students were invited to participate in focus groups to give their opinions on the mandatory TPC program at the University of Louisville's Speed School of Engineering. Overall, students report the TPC program as a positive experience, but the equipment costs were high. Additionally, the evaluation of underrepresented students' background showed differences in previous computing experience. The results indicate that schools with mandatory computer requirements should allocate special attention to minority, financially disadvantaged, or less computer-aware students.**

Index Terms – Tablet PC, Gender, Race and Ethnicity

INTRODUCTION

In this increasingly digital world it is important to be highly technologically aware and proficient, especially for students earning degrees in science, technology, engineering, and mathematics (STEM). Many of these students are expected to understand aspects of technology naturally, or with little effort, because of their chosen field of study. However, not all students begin their college education with the same amount of technological knowledge. The Speed School of Engineering (SSE) at the University of Louisville has adopted a mandatory Tablet Personal Computer program in order to enhance the classroom environment.

A Tablet personal computer, commonly referred to as TPC or Tablet, is a type of slate-style laptop computer [1]. The TPC has a biaxial swivel screen and a digitized pen or touch input for the screen. These qualities enable users to write directly on the screen in a manner similar to taking notes with pencil and paper. TPCs may also be equipped with the traditional track pad and keyboard, similar to a laptop computer.

Students entering the Speed School of Engineering (SSE) in 2006 were recommended, but not required, to purchase a TPC, and a TPC became a requirement for all incoming freshman and transfer students in Fall 2007.

The minimum requirements for the 2009 intake class, according to the SSE TPC website [2], are:

- Convertible Tablet PC with an Active Digitizer Pen
- Windows Vista, 32-bit Operating System
- Core 2 Duo Processor
- 120 GB Hard Drive
- 2 GB of RAM
- Graphics Card with 256MB Memory
- Wireless 802.11g/n
- DVD Drive
- 3-year Warranty with Theft/Accident Protection

The recommended accessories include:

- Mouse with scrolling button, wired or wireless (needed for EG 150 graphics course)
- USB flash drive for file storage
- Carrying case or backpack
- Travel battery for extended battery life
- Backup digitizer pen

It is no secret that the difference in enrollment and retention rates for underrepresented populations versus the majority is staggering. At SSE, males are an overwhelming majority in every intake class [3]. A study by Felder, et al. determined that women in engineering comprise 15.0% of B.S. degree earners, 14.8% of M.S., and 9.7% of Ph.D. In the professional world, women are a vital part of the work force, but as of 1988 they represented only 4% of practicing

engineers in the US [4]. The outlook for racial and ethnic minorities is equally bleak. The Science and Engineering Indicators, released by the National Science Foundation, states: "The percentages of blacks and Hispanics ages 25 to 29 in 2003 who completed bachelor's (sic) or higher degrees [in science and in engineering] were 18% and 10%, respectively, compared with 34% for whites"[5].

There are a number of universities with TPC programs, including, but not limited to, Duke University [6], University of Illinois Urbana-Champaign [7], and Virginia Tech [8]. Since many schools are beginning to incorporate TPC programs, the University of Louisville (UofL) also began a program to keep its students abreast with ever-changing technology. However, there are very few studies which discuss the educational outcomes related to the integration of *mandatory* programs.

One of the major influences on classroom effectiveness is the instructor. Campbell and Pargas investigated how instructors could deliver their material more effectively to the students [9]. The topics they discussed included posting class materials online, collaborative learning exercises, and laptop etiquette and discipline. UofL currently uses the Blackboard Academic Suite™ (Bb) system for instructors to be able to post all types of class materials, for students to communicate with the instructor and fellow students, and for students to review their grades.

Evaluating computers in the education environment with respect to gender or ethnicity is not uncommon. Of the immense research in this area, the study by Wolfe [10] is a close comparison to the current study. The study compared computer assisted communication to the traditional mode of classroom communication, face-to-face, in an undergraduate student population. The research team reported different communication patterns along the ethnic-gender groups of Caucasian or Hispanic and females or males, consistent with the study's population composition in a Texas university. When the research team first analyzed results by ethnic group or gender separately, no statistical significance was found. However when the data was analyzed in ethnic-gender groups, statistical significance was found, and overall the differences were between Caucasian females, Caucasian males and the Hispanic population.

The goal of this study is to investigate the perceived impact of the TPC program on all students, with a focus on underrepresented populations, by studying:

1) computer usage patterns,
2) time management,
3) retention, and
4) educational outcomes.

METHODS

This study utilized a questionnaire and a focus group to investigate student attitudes towards the TPC program. The questionnaire was posed to all students and faculty at SSE, while the preliminary survey for the focus group was posed to students in specific intake classes, whether currently enrolled or not. Researchers briefly explained the study, and participation was voluntary. Compensation was given for participating in the study including a t-shirt for questionnaire respondents and cash compensation for focus group participants. The Institutional Review Board approved the protocol for the study.

I. Subjects

Preliminary data analysis for the current study indicated that Caucasian females tended to answer similarly with each other, and somewhat different from other underrepresented groups. A study by Wolfe [10] showed similar trends: while all participants were grouped together, there was no statistically significant data, but when the responses were grouped by ethnicity and gender, significant differences appeared. Therefore, for this study, the subjects were classified into 3 groups: Caucasian (White, non-Hispanic) males, Caucasian females, and Minorities which includes all respondents who did not select White non-Hispanic. Students who selected Multi-ethnic for Race/Ethnicity, or who selected two or more categories for Race/Ethnicity, were grouped into the Minority classification. The term Underrepresented refers to the combination of Caucasian females and Minorities. A table summarizing this is below.

TABLE 1
SUBJECT CLASSIFICATION

Gender	*Race/Ethnicity*	*Classification*	*Code*
Male	White, non-Hispanic	Caucasian Male	CM
Female	White, non-Hispanic	Caucasian Female	CF
Male or Female	African American, American Indian or Native American, Asian or Pacific Islander, Hispanic or Latino/a, Multi-ethnic	Minority	M

II. Introductory Study: Questionnaire

A custom questionnaire was developed for this study investigating educational impact, ergonomics, and time management impacts of the TPC program. Student recruitment was performed through announcements in classes and word of mouth. The students were informed of the voluntary nature of the study via the informed consent paragraph at the beginning of each questionnaire, or in the preliminary survey before each focus group.

The study was a convenience sample, as the research team only studied the student population at one university. The study focused on student involved in the Tablet PC ownership program. Students interested in participating in the questionnaire were given an individual code to enter. Unique code cards were passed out to potential participants, in order to be able to calculate a response rate, and to ensure the uniqueness of every respondent. The participants entered the codes into the online survey, and duplicate or erroneous responses were excluded.

The questionnaire was administered in the 2008-2009 academic year, two years after the SSE began the mandatory

Tablet PC ownership program. One hundred eighty nine students entered the study, for a response rate of 75.9%, with a completion rate of 90%. The questionnaire collected information regarding duration, frequency, posture, and discomfort associated with the student's computer use, and also asked about the educational impacts of the TPC program. The participants answered questions specific to their primary computer: Desktop PC, Laptop/Notebook PC, or Tablet PC. The results presented in this paper focus on the educational impacts of the Tablet PC program, and the results of the coinciding focus groups.

III. Main Study: Focus Groups

SSE undergraduate students were contacted via email to participate in the preliminary focus group survey, with a specific emphasis on the 2006-2008 intake classes. The 2009 intake class was contacted through the Introduction to Engineering class. The preliminary survey determined the students' schedule availabilities and demographic information. Focus groups were formed from the cadre of interested students and based upon their availability.

In the focus groups, students were given name badges with a color written on them instead of their names. The students were instructed to say their "color" before responding to any question to maintain anonymity. Students were asked pre-determined questions pertaining to education and retention, and were encouraged to answer the questions as fully as they felt comfortable. The audio of the focus group was recorded and later transcribed for further analysis. The moderator also made brief notes. An example question was: *"Are there any limitations in the classroom?"*

After completion of the focus groups, several students expressed interest in participating but were unavailable to attend any focus group because of schedule conflicts. A digital version of the prepared questions from the focus groups was therefore created and distributed to those students. The digital version provided space for students to give any additional comments beyond the question answers.

IV. Focus Group: Data processing

Even though the focus group questions were prepared in advance, students were also encouraged to discuss openly issues related to the TPC program in a group of their peers. As a result, although the responses were centered on the students' perception of TPC program effect on their studies and the technological awareness of professors, the discussion included other issues such as cheating in the classroom, computer recycling programs and differences in individual learning styles. All similar responses were coded for ease of processing, e.g. 'Yeah' coded to 'Yes'. For open-ended questions, the 3-5 responses most frequently given were grouped and coded, and all other responses were designated as "other".

The responses from both the traditional focus groups and the digital version were compiled into Microsoft Excel 2007. The responses were then coded and imported into SAS Enterprise Version 9.2 for open-ended or complex statistical analysis.

RESULTS

The study was completed in 2009, three years after the University of Louisville Speed School of Engineering (SSE) began a Tablet PC program. Two hundred forty one students entered the questionnaire, for a response rate of 88% and a completion rate of (84%) (n=202); Of these, 151 were undergraduate students. Sixteen undergraduate students participated in the focus groups, with a completion rate of 100%.

The questionnaire and focus group participants' demographic information is shown in Figures 1 and 2.

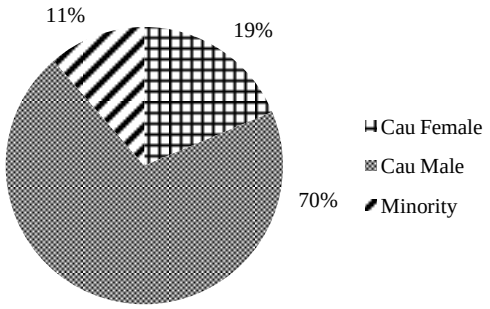

FIGURE 1
DEMOGRAPHICS OF QUESTIONNAIRE PARTICIPANTS

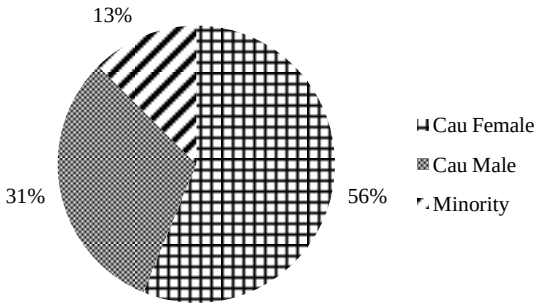

FIGURE 2
DEMOGRAPHICS OF FOCUS GROUP PARTICIPANTS

I. TPC Usage and Academic Performance

This paper examines the student perceptions of the TPC program, including the impact on their education. Usage of TPC usage was widespread, with 61% of focus group participants reporting that they used their TPC in "all of my classes" or "some of my classes". Similar results were found in the questionnaire data, with 44% of students reported daily use of a TPC. Only 36% of Focus Group participants indicated that the TPCs were required in their

classes. From this data, it is observed that students are using their tablets; however, professors are not requiring their use in every class, even though it is mandatory for all incoming students to purchase a TPC.

The vast majority of questionnaire respondents, 76%, did *not* feel their grades were worse because of the TPC program while 15% were neutral regarding the impact on grades. When only looking at TPC users, 78% did *not* feel their grades were worse, and 13% were neutral. The remainder (9%) felt that their grades were negatively impacted.

Student opinions regarding the use of TPCs by professors were also studied. In the focus groups, 92% of students {85% CF, 100% CM, 100% Min} said their professor used a TPC while lecturing in class. Of these students, 100% felt the professors need a training session on TPC use. Only 33% {50% CF, 33% CM, 0% Min} felt that a difference in technical level between the students and the professor was an issue. Some of the issues regarding the technical skill of the faculty included: students without TPC who were unable to follow a professor who makes a complex diagram, and students who become frustrated and "zone out" when a professor cannot handle a technical difficulty in the middle of class. Also, 40% {50% CF, 33% CM, 0% Min} of students said they or someone they know avoided registering for a class because of that specific instructor's use or misuse of the TPC.

Eighty percent of questionnaire respondents selected "agree" when asked if they had a professor who used a TPC in class. Only 3% disagreed with the statement that the professor allowed the use of TPCs in class.

Lastly, TPC misuse was addressed. Focus group participants gave examples of TPC misuse that they had seen: multitasking while in class instead of taking notes, including playing games, chat, and browsing social networking sites, and organizing a coordinated chat room for in-class tests which computers were allowed. Eighty-eight percent of students {100% CF, 60% CM, 100% Min} reported that a professor *did not use* an available feature to block access to non-class related programs while in class. When specifically asked about cheating, 25% {17% CF, 40% CM, 0% Min} felt TPCs were being used for cheating.

In the questionnaire, 20% of students agreed that they were distracted by their own or another students' TPC in class, while 20% were neutral.

II. TPC and Potential Obstacles

The second issue this research assessed was any obstacles or potential obstacles of a mandatory TPC program. Obstacles most frequently noted in both the Focus Group and the questionnaire were the cost of the TPC and previous PC experience,

A concern which was overwhelmingly reported was the price of the TPC. In the focus group, 92% of participants felt that the price of TPCs was an issue. One participant even said:

> "Speed School students pay the same as Arts and Sciences students to go to school. But, to have almost an extra $1500 expense [is] a lot to come up with for [the first] year."

The questionnaire respondents also raised cost as a concern, and stated that one reason they did not like the TPC program was because of cost (56%).

Students also felt that computer experience and technical knowledge was a concern. In the focus group, 91% {100% CF, 75% CM, 100% Min} of the participants felt that students who started their college career with a TPC had an advantage over those who did not, i.e. those students who were in the intake classes with the TPC mandate have an advantage over those who were in intake classes that the TPC was optional or not even a consideration.

In the questionnaire, the average number of years of computer usage was 13.8, 13.3, and 10.5 for Caucasian Males, Caucasian Females, and Minorities, respectively. A t-test was performed, and the difference between Caucasian Female or Caucasian Male versus Minorities is significant ($P<0.0001$). This difference may be caused because minorities may have less access to computers at earlier ages, and fewer resources when entering college. A graph of the results is in Figure 3 below.

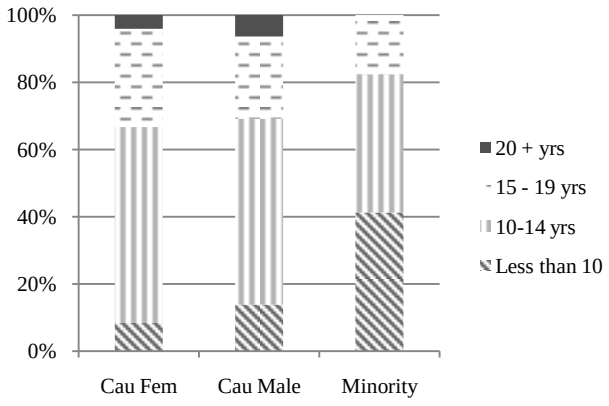

FIGURE 3
YEARS OF COMPUTING EXPERIENCE

III. Student Recommendations from Focus Groups

In the focus groups, the students commented that, overall, they enjoyed using the TPCs and the TPC program. Students also gave recommendations on how to make the program better.

Primarily, students gave recommendations on the tablets themselves. One subject the students mentioned repeatedly was that the battery life on their computers rapidly declined. The layout of the classrooms exacerbates the problem. The students complained that not all classrooms are designed to allow the students in the class to charge their TPCs. The students recommended that the classrooms be updated to enable more of them to be able to charge their tablets. They also recommended there be class session in the Introduction

to Engineering class or an open lab which explained how to properly maintain the computers and the battery life.

As discussed in the previous section, many students felt the cost of TPCs was an issue. All of the students agreed that incoming freshmen at University of Louisville and other universities are purchasing some type of computer when they begin postsecondary education. Since tablets can cost $400-$1000 more than a similarly built laptop computer, students may not feel this increase in cost is justified if TPCs are not used in every class, or at least the core classes. The students had many suggestions on how to address the cost issue, including:

- Scholarships and grants specifically for TPC funds
- A rental program in which the tablet is returned to the school upon completion of a degree program or withdrawal from the program
- A donation program in which used tablets can be bought and sold, similar to used books at a campus bookstore
- USB Tablet pads to be used with a laptop

The focus group participants were also asked if the university was doing enough to reduce electronic waste, or e-waste, generated by TPCs. The US EPA estimated that 4.6 million tons of e-waste from devices such as computers, cell phones, and other electronics were dumped into US landfills in 2000 [11]. In order to decrease the effect of TPCs in landfills, the students suggested donating used TPCs to students in need, having a repair program, and selling or donating old TPCs for parts. One student felt that, though these ideas were straightforward, the university "still needs paper recycling bins".

Students also had suggestions about improving the role of professors in the TPC program. They suggested that professors receive training on the functions of the TPC, similar to the students' training in the Introduction to Engineering class.

While students agreed that professors and students could create an organization to address issues that pertain to SSE students and faculty, they also felt that it was equally important to act on issues. Students said that if the student body did not feel like any action would be forthcoming from any recommendation from such group then student interest would decline or become nonexistent.

DISCUSSION

The goal of this portion of the study was to investigate the impact of the TPC program on educational outcomes, particularly for underrepresented students.

I. Comparison to Other Studies

While both professors and students are using TPCs in class, some effort may be required to close the gap between the level of technological expertise between professors and students. Some students may become frustrated when a professor does not allow students to use mandated TPCs for classes, or when the instructor is not using a TPC.

Despite the fact that the use of TPCs is not yet widespread, nor do professors have extensive experience in their use, it is interesting to note the students did not feel TPCs made their grades worse. A study by Sneller [12] shows similar results. In this study, the students' thoughts on the mandatory use of TPCs in the classroom, as well as a comparison of the grades of those students and the students who did not have the TPC mandate, were analyzed. The study shows that the students felt their classroom experience was enhanced, they enjoyed using the TPC, and that it helped them to learn. The course grades of the students with the TPC mandate were higher than course grades of students from the previous year. However, no outside metrics were used to compare the aptitude of the students before they entered the class. These results are similar to the results of this study. Even though the current study did not specifically focus on grades, students felt the TPC improved their classroom and learning experiences.

There is still a gap to bridge when considering the role of professors in a mandatory TPC program. While some professors may be excited, and even willing, to modify the classroom experience to include TPCs and digital notes, others may not feel the same. Weitz, et al [13] created a study specifically for professors and analyzed their use of computers in the classroom. At this university, students and faculty are issued a laptop computer with the option to upgrade every two years. The faculty members eligible for an upgrade were asked if they would like to keep their current model, upgrade to the newest laptop, or upgrade to the newest tablet; Only 64 of the 220 respondents requested the tablet upgrade. Of these participants, 59 responded to the follow-up questionnaire and 45 reported they used the tablet functionality in at least one class. Students in the current study reported that most of the professors who use the TPCs are professors at SSE in the core classes: Calculus, Intro to Engineering, etc. This suggests that professors who teach general education courses or upperclassmen courses are not using the TPCs. These professors may have many reasons for not wanting to use TPCs, but if the program is mandatory for the students it creates problems if all professors are not using TPCs in their classes.

The cost difference in TPCs and laptops is still a major issue, as seen in other studies. Berque et al [14] provided recommendations on improving the cost effectiveness of TPCs. They discuss "pen-based classrooms" where the workstations are desktops with a USB tablet pad attached to the computer. These workstations would remain in the classroom, similar to a computer lab. The study also recommends obtaining bulk discounts from companies which sell TPCs to keep costs low. The program at SSE has a similar initiative for TPC costs, but the difference in cost between a laptop with a USB tablet pad and a TPC is still large enough that students consider it a problem. If the aim of a TPC program is portability, students should be allowed to purchase laptops with a tablet pad. Additionally, if

professors choose not to use tablets in their classroom for upperclassmen, students may feel that they wasted their limited resources on technology that is not used.

While the growth of technology is certainly not a negative thing, appropriate class etiquette regarding technology needs to be addressed. Class etiquette for electronic devices is important to keeping students focused on the class discussion. The software program DyKnow, used at SSE, can assist the instructors in managing these issues, but all instructors and students must have the software installed for successful implementation. Some of the students from the focus group and questionnaire indicated that having a TPC or PC was a distraction in class, and that students were misusing the computer access (cheating). Etiquette should be reviewed and updated at the same rate that technology is updated. There are certainly etiquette rules for phone calls during class, but there are few, if any, in place for texting, online chatting, web browsing and playing games during class. Campbell and Pargas [9] completed a study with university professors to define laptop-etiquette rules; the rules which most closely related to the students' reported issues in this study are:

- Every cell phone, beeper, laptop volume control, pager, personal digital assistant, should be set to *mute* or *off* before coming to class. If any of these devices rings, beeps, or plays in class, you will be marked *absent*.
- If you engage in unauthorized communication or entertainment (surfing, instant messaging, chat room chatting, DVD viewing, music playing, game playing, etc.) during a quiz, you will receive a grade of 0 for the quiz. A second offense will result in a formal written charge of academic dishonesty.
- If you engage in unauthorized communication or entertainment during lecture, you will be marked *absent*.
- Students participating in a NetMeeting should not request for control of the screen until the professor grants permission to do so.

If etiquette rules such as these are implemented in the classroom, students will be less likely to be distracted by their own behavior or the behavior of other students. Regardless of the actual rules chosen, they must be codified so that the rules, and consequences of violations, are clearly defined for the students.

II. Limitations of the Study

Although one of the proposed objectives of this research was to analyze the educational outcome, particularly relating to the retention rate and the GPAs of students and the SAT/ACT scores of the intake classes, SSE was unwilling to release this data to the research team and no comparisons were possible.

III. Improvements for Future Studies

One potential improvement would be to draw more students into participating in the surveys and focus groups. Similarly, the researchers work with the Introduction to Engineering class, which all Freshmen are required to take, to ensure participation of all members of the incoming class. Since the composition of students at SSE is primarily male, it is especially difficult to recruit sufficient numbers of underrepresented students for studies such as this. In the future, researchers should consider limiting the scope of some focus groups to only underrepresented student populations.

In one particular focus group, the students began talking about their learning styles and the effect it had on their TPC learning curve. Adding standardized learning style questions would allow for additional comparisons, and potentially insight into the content of required training programs. This study only briefly touched on the amount of student computer experience prior to admission. The difference in years of experience may account for some students' hesitance at adopting a mandatory tablet program. If there were a course to bring students up to a baseline computer knowledge level, similar to classes for mathematics background, students with fewer years of experience can have a place to learn without feeling lost in a sea of computer jargon.

An ongoing study could compare the results from different years to see if experience improved the program. The survey could also be administered at other colleges and universities with a mandatory TPC program, an optional TPC program, and no TPC program. The results could then be compared across different populations, with a potentially larger base of minority or underrepresented students, and different approaches to implementation and training.

CONCLUSION

In conclusion, the students at SSE really do enjoy their TPCs. Students and faculty alike can benefit from the improved, interactive classroom. In order to bring the program out of its infancy, some issues need to be addressed, including the technological knowledge of the students and faculty, the price of the TPCs, and the widespread use of TPCs by professors.

Additionally, programs need to be in place to keep all students on equal footing. When a person hears or sees the word 'minority' he or she may automatically think racial minority, but in the world of STEM, females are also a minority. Special programs for underrepresented populations to be able to afford things such as a mandatory tablet or not be intimidated because of a lack of technical knowledge may be just what the STEM disciplines need to encourage and promote diversity at school and in the workplace.

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