Cost-Effective Integration of Tablet Technology into Engineering Courses

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Abstract

Current generations of students are part of a digital revolution in which they collaborate and learn through digital mediums and remain connected 24/7. Educators across the board have embraced these rapid changes and, with the aid of classroom technologies such as Tablet-PCs (TPC), have seamlessly transformed traditional teacher-dominated classrooms into dynamic, digitally rich student-centered learning environments. In order to bestow a competitive advantage on their students, nations are investing heavily in digitally rich environments to boost student learning and achievement of their future workforce, which in turn will help them remain competitive in the global marketplace. Therefore, widespread and fast adoption of digital learning technologies such as TPC are imperative for increasing probability of student success, thus maintaining our nation's competitiveness. However, educators face daunting challenges at different levels to create a digitally rich environment using tablet technology thus prohibiting its widespread adoption. This paper discusses a cost-effective integration of Tablet technology into traditional engineering courses to make students' classroom experience more efficacious. The paper includes resources needed to convert existing classrooms into either a "single-tablet model" or a "multi-tablet model" and also evaluates the hypothesis that integration of tablet technology, using cost-effective USB-Tablets increases, student learning by means of student evaluation.

I. Introduction

It is a well-accepted fact that with the digital revolution, the structure and nature of student learning has changed dramatically from what was and continues to evolve. Current generations of students are part of this digital revolution where they collaborate and learn through digital mediums and remain connected 24/7. Educators across the board have embraced these rapid changes and, as a result, today's classrooms have been restructured resulting in shifts in teaching from a traditional teacher-dominated approach to a dynamic, digitally rich student-centered approach that enables students to be self-learners.

One of the technologies that facilitated this shift is the Tablet-PCs (TPC). TPC in combination with an interactive educational software (such as *Dyknow Vision* and *Classroom Presenter*) and classroom management software (such as *Dyknow Monitor* and *LanSchool*) have helped to seamlessly transform traditional classrooms into digital learning environments. Using this technology, instructors can, a) progressively present both prepared and extemporaneous class material using digital ink which can be saved for future review, b) solicit active participation from all students during lectures to conduct immediate and meaningful assessments and to provide needed feedback and assistance in realtime to maximize student learning, c) be mobile, d) face the class and not obstruct visual presentation of material, e) remotely monitor each student during class sessions and minimize "electronic distraction." TPC improves student

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learning and allows students to view information on their computer, take personal notes directly on provided slides, and save the information for future reference and review. The numerous implementations of TPC demonstrate the usefulness of this technology to increase interaction between faculty and students and it has shown improvement in learning and retention of material [1 – 4]. TPC is suited for analyzing and solving engineering problems and it provides an ideal venue for applying interactive teaching.

In order to bestow a competitive advantage on their students, nations are investing heavily in digitally rich environments to boost student learning and achievement of their future workforce, which in turn will help them remain competitive in the global marketplace. Therefore, widespread and fast adoption of digital learning technologies such as TPC, that have proven to enhance student learning, are imperative for increasing probability of student success, thus maintaining our nation's competitiveness. However, educators face daunting challenges at different levels to create a digitally rich environment using tablet technology thus prohibiting its widespread adoption. The primary impediment is the prohibitive hardware cost of digital learning technologies like TPC.

This paper discusses a cost-effective integration of Tablet technology into traditional engineering courses to make students' classroom experience more efficacious. The integration will rely on USB-Tablets ($58 - $170) along with interactive educational and classroom management software. The paper includes resources needed to convert an existing classroom with PCs into either a "single-tablet model" or a "multi-tablet model." The paper also evaluates the hypothesis that integration of tablet technology using cost-effective USB-Tablets increases student learning by means of student evaluation.

II. USB-Tablets

Fig. 1. Wacom Wired USB-Tablet with 5.8" x 3.6" active area ($58)

Fig. 2. Wacom Wired USB-Tablet with 8.5" x 5.4" active area ($170)

A USB-tablet is a computer input device connected to the USB port of the computer that allows one to write and hand-draw images using a stylus, a pen-like drawing apparatus. The image does not appear on the tablet itself but, rather, is displayed on the computer monitor. There are a variety of USB-tablets available in the market today ranging in size (active area), and capabilities (Figs.1 and 2). Wireless tablets (Fig.3) are also available that will enable the instructor to be mobile.

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Fig. 3. Wacom wireless pen tablet with 8.0" x 5.0" active area ($374)

III. Single-Tablet and Multi-Tablet Models using USB-Tablets

In the single-tablet model, the instructor's tablet is connected to the PC with a projection system. Single-tablet models can be used in classrooms along with interactive educational software or with freeware such as *ScreenPen* alone that allows you to highlight, write and save slides with annotations using digital ink for future reference. Wireless tablets (Fig.3) are an ideal choice for the single-tablet model classrooms. Using this model, any traditional classroom can be seamlessly converted to a digital learning environment in a cost-effective manner as only a single tablet is required. However, the single-tablet model lacks the ability to gather instant student feedback using digital ink.

In the multi-tablet model, both the instructor and students have USB-Tablets. This model can be adopted in classrooms with networked PCs installed with interactive educational and classroom management software. The single-tablet and multi-tablet models using USB-tablets are not only as effective as the TPCs but are also a cost-efficient method to integrate tablet technology into classrooms.

IV. Pilot Study - Single-Tablet Model Implementation in Two New Engineering Courses

In Fall 2010, a pilot study using USB-Tablet was conducted to ascertain its effectiveness in engineering courses. The single-tablet model using USB-Tablet (Fig. 2) was adopted in two new engineering courses, 1) EGGN100 – *Introduction to Engineering* (Total enrollment: 84, two sections) and 2) EGCP 456 – *Introduction to Logic Design in Nanotechnology* (Total enrollment: 13, one section). *ScreenPen* freeware was utilized to elaborate concepts using digital ink annotations (Fig. 4).

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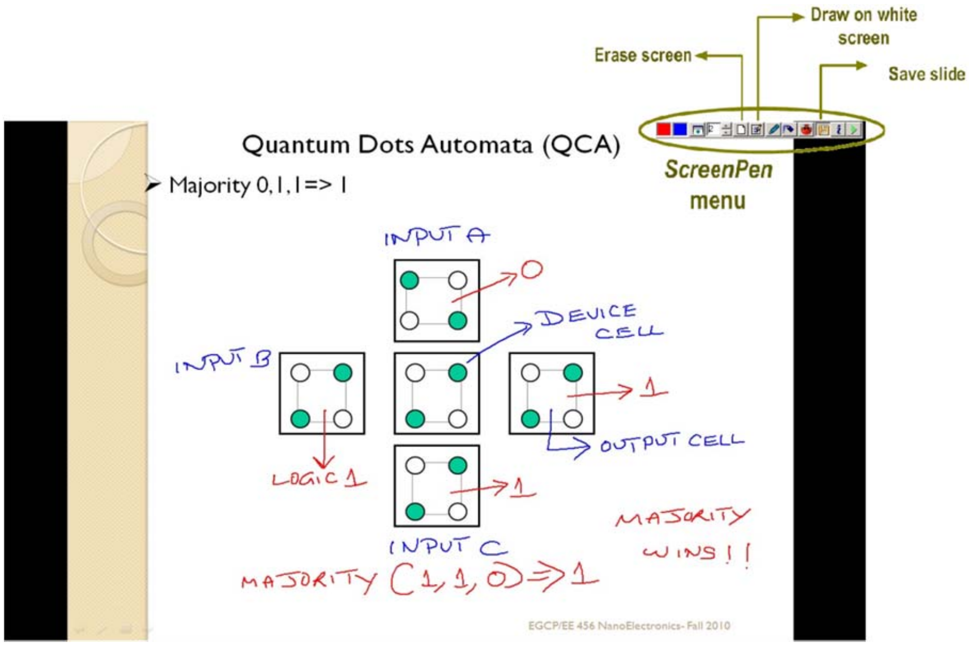

Fig. 4. Annotations using digital ink on lecture slides in EGCP 456 class

a) Challenges Encountered

One of the challenges faced was the selection of appropriate software for digital ink annotations. During the first few weeks of class, several freeware programs were tried out. While some software crashed during lectures, several others slowed down the presentation delivery as they were CPU intensive. *ScreenPen* freeware however proved to be a good resource that came with a simple menu along with a user friendly interface.

The second challenge encountered was the hand-eye coordination that is required as images drawn on the tablet do not appear on the tablet itself unlike a TPC but, rather, are displayed on the computer monitor. This is very similar to the hand-eye coordination required for a computer mouse. However, just as with the computer mouse, good hand-eye coordination was gained with USB-Tablets with minimal practice.

b) Student Feedback and Analysis

A student survey was constructed to measure students' perceptions of the USB-Tablets in engineering classrooms. The survey included four questions with responses: strongly disagree, disagree, neutral, agree, strongly agree along with two questions with free-response answers. The overall student response was lower than expected (EGGN 100 (section 1): 17/31, EGGN 100 (section 1): 37/53, EGCP 456: 9/13).

Fig. 5(a) summarizes the student response to the first question in survey, "*Using the Tablet technology increased my understanding of the lecture.*" Approximately 52% of the students

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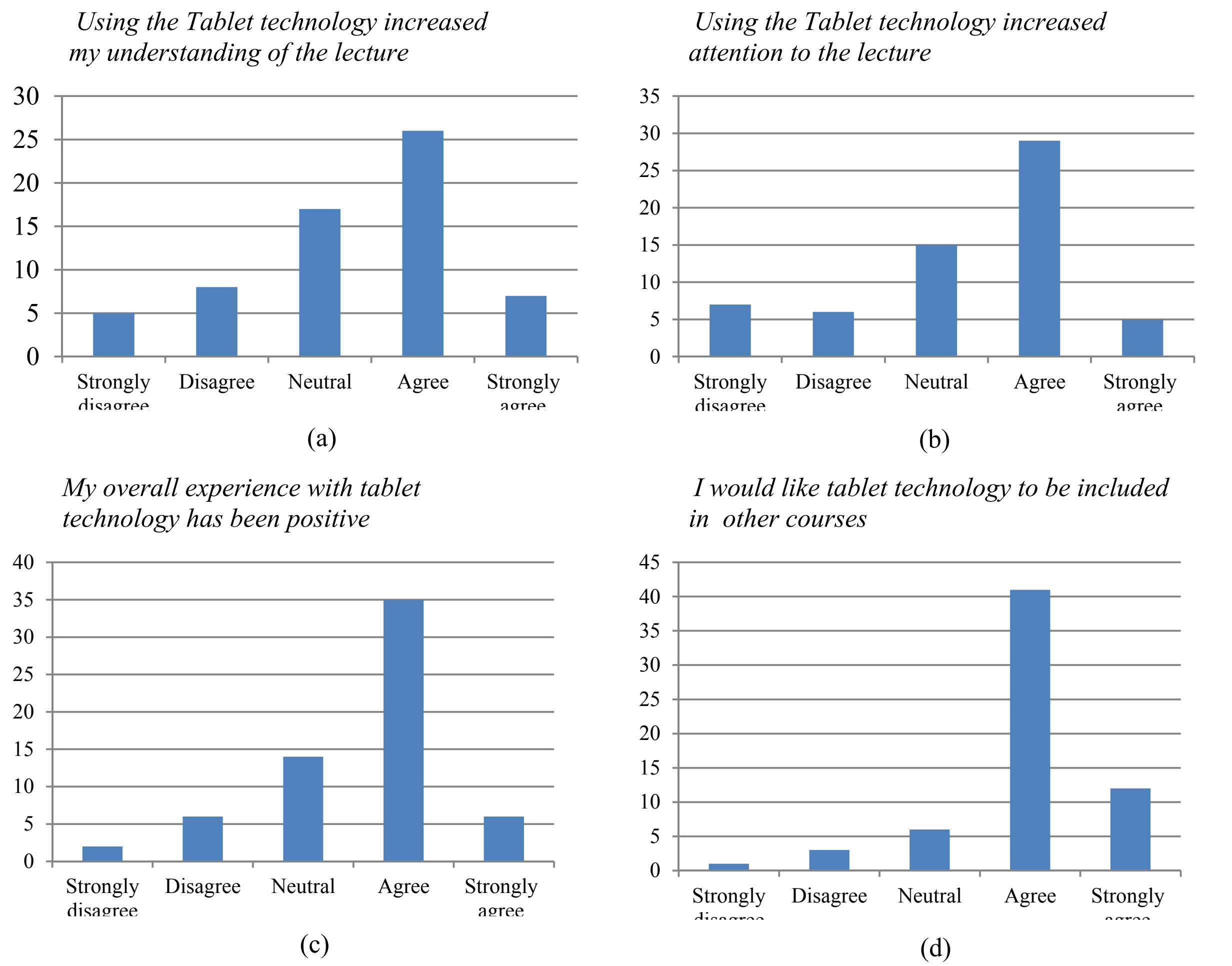

Fig. 5: Student survey questions and feedback

agree that their understanding of the lecture was improved with the use of tablet technology in their class. Many students pointed out in their free-response answers that with the tablet technology they were able to focus on comprehending the class material rather than taking notes for future reference. Fig. 5(b) summarizes the student response to the second question in survey, "*Using the Tablet technology increased attention to the lecture.*" Approximately 55% of the students agree that they were more attentive during the lecture as the use of tablet technology helped them focus on a single location rather than taking notes from different parts of a white board. The overall survey response from students and their personal feedback on the effectiveness of the USB-Tablet in improving their learning experience was positive. Approximately 65% of the students surveyed agree that they had a positive experience with the use of tablet technology in the class (Fig. 5(c)) and 84% of the students wanted tablet technology to be included in other classes as well (Fig. 5(d)).

The sample size involved in this pilot study was small. Classes of larger sizes are needed in the future to further study its effectiveness and also to verify the benefits of instruction in larger class sizes. Furthermore, the impact and effectiveness of USB tablets in class needs to be evaluated using a control group that uses traditional teaching techniques, and an experimental group that uses the tablet technology.

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V. Conclusion

A cost-effective integration of tablet technology into traditional engineering courses to make students' classroom experience more efficacious was described. The paper included resources needed to convert an existing classroom with PCs into either a "single-tablet model" or a "multi-tablet model." The survey used to measure students' perceptions of the USB-Tablet implementation in two new engineering courses was analyzed. The overall survey response from students and their personal feedback on the effectiveness of the USB-Tablet in improving their learning was positive. However, to further study its effectiveness and to verify the benefits of instruction more case studies with larger sizes are needed. Furthermore, the impact and effectiveness of USB tablets in classrooms needs to be evaluated using a control group that uses the traditional teaching techniques and an experimental group that uses tablet technology.

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