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A Pilot Project in Evaluating the Use of Tablet-PCs and Supporting Technologies in Sophomore Electronic Technology Courses

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Abstract

In this paper we discuss the impact of using mobile Tablet-PCs and supporting instructional technologies in Electronic Engineering Technology courses. The Tablet-PC pilot project was implemented in two sophomore electronic courses that directly impacted over 30 students. The instructional technologies used were NetSupport School for classroom management, Windows Journal for note-taking, and Classroom Presenter for creating dynamic presentations. To maximize the usage of Tablet-PCs and supporting instructional technology tools, these courses were redesigned to include lecture slides, oral presentations, audio-video demonstrations, in-class collaborative activities, group discussions, and group projects. The use of NetSupport School Classroom Management Software (CMS) in conjunction with a Tablet-PC improved instructor's course delivery by centrally instructing students on their Tablet-PCs, broadcast the dynamic screen contents along with electronic ink in real-time, maintaining student attention by monitoring the applications and web usage, and save time by quickly polling the class and showing results instantly. The students shared their work instantly with other students and the instructor. This improved collaboration between students and faculty and added new dimension to the learning environment in the classroom. In addition, the use of mobile Tablet-PC technology and supporting note-taking and CMS tools proactively involve students in the learning process with less latency in feedback from instructor. The results from the pilot project show significant improvement in student performance and overall course grades compared to previous years. The technology integration, redesigned courses, pedagogical approach, impact on students learning, and students' attitude towards the technology-enabled learning environment is discussed in the paper.

Introduction

The seven principles of high quality teaching are defined as, student-faculty contact, collaboration among students, active learning, provide rapid feedback, task on time, communicating high expectations, and diverse talent and ways of learning [1]. Research has shown that these teaching principles can be easily accomplished with the positive attitude towards use of instructional technology tools in classroom [2][3]. Technology integration not only brings changes to instructor's instructional roles in the classroom, but also shifts the dynamics of classroom as students become more self-directed. The instructor's role in a technology-infused classroom shifts to that of a facilitator rather than a lecturer [4].

Tablet-PCs with pen-based computing and hand-written recognition software is quickly gaining popularity as an educational tool that make students a more active part of the learning process [2][5]. The ink-based presentations created on Tablet-PC can be made available to students with different accessibility needs. Electronic distribution of lecture materials creates the possibility of tailoring course materials to meet the needs of individual students. Electronic distribution could also enable deaf students to submit (in real-time) written questions about the lecture materials. The handwritten lectures created on Tablet-PC can be saved as digital file, allowing instructors to make their notes available to students for review, helping students to concentrate on the lecture rather than worrying about taking notes from the whiteboard.

Recently, wireless and mobile technologies are being used to effectively change the instructional practices in classrooms. Studies have demonstrated that wireless learning environments can increase students' usage time of instructional technology and improve their learning achievement and attitude [6]. Wireless technology has many features which benefit the implementation of learner-centered instruction. Introducing wireless learning environment into the classroom has encouraged instructors to change the instruction to fit the features of the mobile technology. Wireless mobile Tablet-PC can help students to access online courses and communicate with other students or teacher. With classroom management software (CMS) tools instructor can improve course delivery by centrally instructing their students on their Tablet-PCs, maintain student attention by monitoring application and Web usage, save time by quickly polling the class and showing results instantly, and provide feedback with no latency. The software tools also provide teachers with insight into each student's level of understanding and performance through instant surveys and feedbacks.

Fully adopting the features of these available technologies will necessitate changes from traditional style instruction, thereby causing significant changes in classroom, such as types of classroom interaction, social relationships between students, and the nature of teaching materials and assignments. The pilot project discussed in this paper focused on studying the impact of pen-based Tablet-PCs and Classroom Management Software as technology tools in supporting collaborative learning and pedagogical improvements in classrooms. These technology tools can be used to deliver a more effective pedagogy compared to traditional instructor-centered teaching environments.

The paper is organized as follows. In the next section, authors present a literature review of other Tablet-PC projects. Section 3 will discuss the implementation of Tablet-PC project at ECSU. Classroom learning environment, course redesign, and the classroom pedagogy adopted to improve student engagement and learning in classroom will be discussed in this section. This is followed by results discussing the impact of using technology on student learning and classroom environment. Finally, the relevant conclusion is presented.

Literature Review

Several institutions of higher education have adopted Tablet-PC and supporting technologies in their curriculum. The University of Notre Dame conducted a pilot project to study the efficacy of Tablet-PCs in their computer science curriculum [7]. In a similar project at Seton Hall University faculty members examined impact of Tablet-PCs as teaching and learning tools [8]. Some institutions, such as the Virginia Polytechnic Institute and State University and the Bentley College require incoming freshman engineering students to purchase a Tablet-PC. Virginia Tech is among the first engineering schools to institute such a requirement [9]. It has formed a partnership with Fujitsu Computer Systems and Microsoft that is aimed at changing the way its introductory level engineering classes are taught. A three phase Tablet-PC research project carried out at the Bentley College concluded that the Tablet-PC was the preferred personal computing product in a large number of academic settings, especially where wireless communications and sharing of both ideas and data in a group is important [10]. The University of Ontario Institute of Technology (UOIT) is reported to be the first University in Canada to fully embrace Tablet-PCs, which are currently used in every course at UOIT's School of Science. Faculty members at UOIT have found Tablet-PCs especially useful for presenting math and technical notations during in-class presentations [11].

Individual faculty members at numerous institutions have also used Tablet-PCs to deliver their course content. Faculty members at the Simon Fraser University are using Tablet-PC in their classroom presentations and have realized several benefits of this technology [12]. Faculty members at Canada College developed Tablet-PC-based Interactive Learning Network to enhance the instructor's ability to solicit active participation from students during lectures [13]. Faculty research team at the University of Washington has developed an electronic presentation system based on Tablet-PCs called as Classroom Presenter [14]. The system allows an instructor to lecture from a Tablet-PC that communicates wirelessly with a server connected to a data projector. This allows the instructor to roam freely around the classroom and allow students to write comments that are visible to everyone in the classroom.

Tablet-PC Project at ECSU

In April of 2007, the Department of Technology at Elizabeth City State University received donation from Hewlett Packard (HP) to inititate a Tablet-PC pilot project. The support helped to set up a classroom equipped with twenty Tablet-PCs for use in introductory Electronic Engineering Technology courses and redesign courses to improve student engagement and participation in both classroom and laboratory. In pilot implementation of the project, Electrical Circuits and Analog Electronics courses were chosen for technology integration. Both these courses are laboratory based. Prior to using Tablet-PCs the instructor would usually explain the concepts either through slides or use of whiteboard, with student taking notes. At the end of each lecture, students are given homework assignments. This approach has the following three main limitations, (i) there is limited interaction between student and instructor and virtually no interaction between students, (ii) students often miss assignment submission, and (iii) written or verbal feedback is given at a later date, which is usually overlooked by students. Hence, there is no active engagement of students in the learning process, which severely impacts their learning. The use of Tablet-PCs and supporting tools was a step in the direction to enhance the classroom learning experience. The objectives of this Tablet-PC pilot project is to:

- Increase usage of technology in facilitating enhanced learning and teaching both in classroom and laboratory.
- Promote collaborative work and active learning environment in classroom.
- Improve student-student or student-faculty interaction.
- Develop pedagogical strategies and learn ways to soliciting participation from all students.
- Increase students' active participation in class activities and group discussions,where they take charge of their own learning process.

The classroom learning environment, course redesign, and classroom pedagogy is discussed next.

Wireless/Mobile Learning Environment

The wireless/mobile classroom set up is shown in Figure 1. Each student in class was allocated a Tablet-PC for his/her use for throughout the semester. All tablets, including instructor's tablet was configured on a dedicated wireless local area network (LAN). As shown in Figure 1, lecture presentations can either be projected directly from the instructor's tablet, or can be directed from a second machine (laptop or tablet) that is wirelessly networked to the first. An advantage of the later configuration is that the instructor is free to move during lecture while holding the tablet.

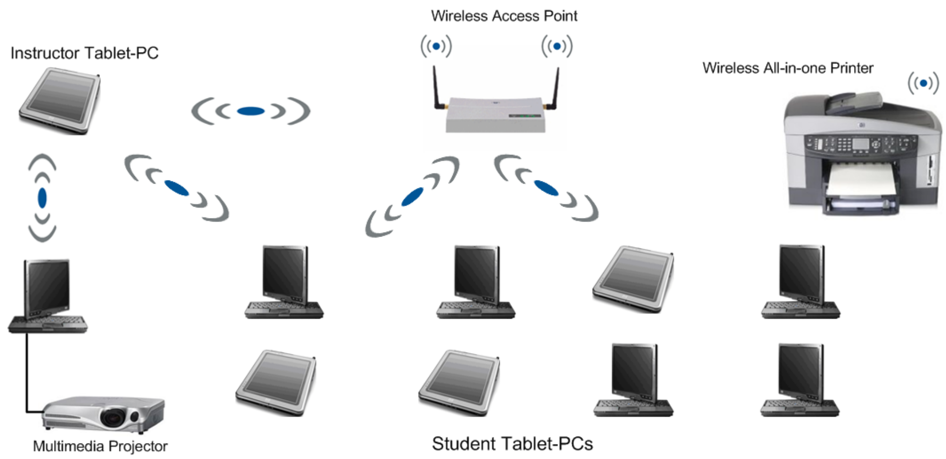

Figure 1: Tablet-PC Based Wireless and Mobile Learning Classroom

In classroom, the instructor's tablet connected to a multimedia projector acted as a virtual whiteboard. The instructional delivery system was designed around NetSupport School (NSS) Classroom Management Software (CMS) [14]. Tablet-PCs in conjunction with Classroom Management Software have a unique ability to support collaboration. The pen-based input of Tablet-PC supports a range of expressions and provides shared workspace for inking, which is the basic structure of a collaborative activity. The students can work on in-class assignments, problem-solving exercises, project discussions, and collaborate both face-to-face and via their tablets.

The instructor can keep track of the students' understanding of subject material through instant surveys and feedback feature of NSS. Using the chat and messaging features of NSS, a student can engage in a dialogue with the instructor without disturbing the entire classroom. During in class collaborative activities, the instructor used NSS's group feature and assigned groups and group leaders. The group leader was able to monitor/access the tablets used in his/her group and communicate with the instructor. The key features of mobile Tablet-PC based wireless learning environment are (i) support and monitor student learning activity in a mentoring role, (ii) facilitate communication and collaborative group work activities, (iii) facilitate enhanced project work by recording and replaying audio, (iv) Provide instant feedback in response to a survey question, and (v) facilitate e-record/portfolio of student work that can be made available on an institutional repository.

Course Redesign

The supplemental model was adopted for redesigning courses. In this course redesign model, the course reading material and assessment was made available online in advance. The courses were redesigned with three main goals in mind:

- Increase the availability of content to the students outside of the classroom via Blackboard Course Management System.

- Increase the use of interactive technologies in the classroom to promote student participation, group work and student-student interactions.
- Create immediate feedback assessment tools to better manage student-learning outcomes.

Both courses had 5-6 discussion segments or collaborative problem-solving activities. These activities were carefully designed to keep students engaged in classroom. Digital inking afforded through tablets greatly broadened the scope of these classroom activities by allowing convenient expression of diagrams, graphs, schematics, chemical models, mathematical equations, and a wide range of notations that are inconvenient with a keyboard. In laboratory, student used tablets to run simulations, analyze and plot data, and access lecture and other other resources.

Classroom Pedagogy/Methodology

A typical classroom session involved following segments; (i) a 20-30 minutes of lecturing, (ii) evaluation of students understanding, (iii) a short pre-test, (iv) discussion questions or collaborative activities, (v) post-test, and (v) session evaluation.

Web-based content that reinforces specific instructional objectives in the courses was distributed to the students via Blackboard Course Management System. The content was selected based not only on quality, but also on accessibility of format and interactivity. The online content was be assigned to the students as an auxiliary to text readings, and required to be reviewed before class meets. Self-Assessment tools were provided to the students in the form of Blackboard quizzes, as a way to judge preparedness for class time. Students were required to complete self-assessments prior to class. Having freed class time by partially substituting lecture for on-line delivery of content a larger portion of classroom time was dedicated to interactive learning and class discussion/collaborative activities targeting the development of critical thinking and problem-solving skills.

The tablets were invaluable in the implementation of interactive group learning activities; managing students through classroom group activities, and conducting classroom discussions based on web-delivered content was made available on a selective basis via the tablets. Using the tablets, content generated from class discussions, case studies and interactive activities was then saved in electronic formats and uploaded to Blackboard so that all students will be able to reference it.

With the course redesign format it was indispensable that instructor receive regular and immediate feedback from the students to assess learning progress and identify problem areas. Here also, the tablets become invaluable tools. Learning outcomes from pre-class assigned content were assessed via interactive quizzes and questions at the beginning of each class period. On going assessment was performed during the lesson, facilitating assessment of volunteers and non-volunteers. Instructor was also able to monitor the progress of groups doing in-class individual work, and direct work of a specific group without interrupting others.

During the semesters (fall 2007 and spring 2008), Tablet-PCs were used both in classroom and laboratory. In the course, during collaborative activities, groups were formed and group leaders were assigned both in class and laboratory projects (see Figure 2 and Figure 3 for pictures taken during class and lab).

Figure 2: Students Using Tablets During a Collaborative Activity in Classroom

Figure 3: Students Using Tablets in Laboratory

The instructor also involved the students in collaborative note-taking, where each student added to the problem solving assignment during lecture (see Figure 4 for a sample of student notes).

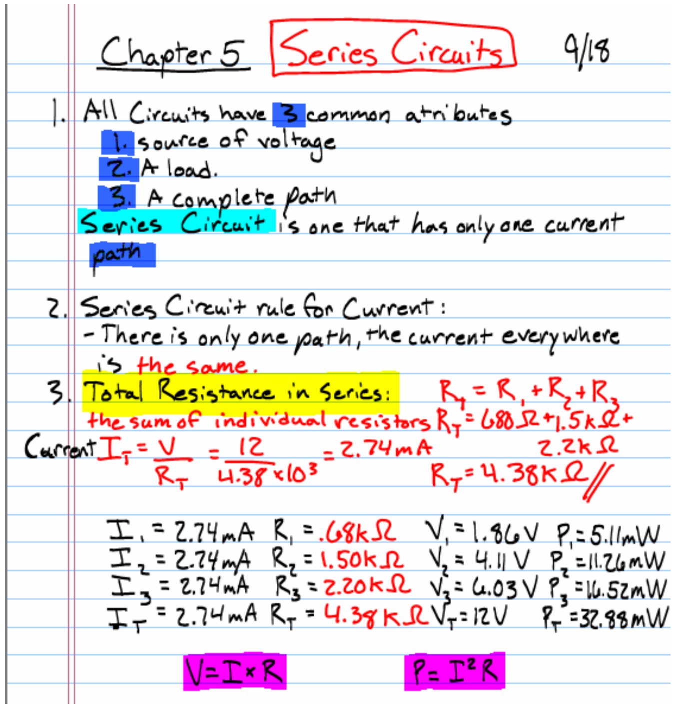

Figure 4: A sample of Student Class Notes

Using NSS, instructor was able to to broadcast the dynamic screen contents along with electronic ink in real-time. Quick polling feature of NSS helped instructor in providing an insight into each student’s level of understanding and facilitate immediate feedback. During in-class collaborative activities, the instructor can monitor and communicate with each group from his tablet. NetSupport School screens depicting chat and survey features are shown in Figure 5.

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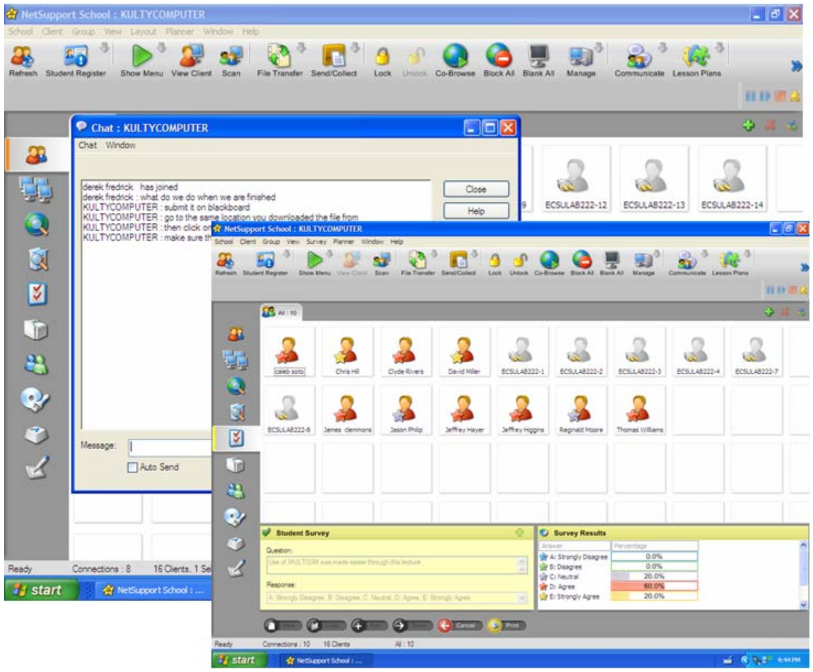

Figure 5: NetSupport School Screens Depicting Chat and Survey features

In some cases, important topics such as circuit analysis steps were recorded as screen activities using Camtasia Studio and made available on Blackboard for later review. Outside the classroom, the digital ink feature and ability of Windows Journal, a note-taking application, to import any printable file format enabled the instructor to grade papers and projects, adding a personal touch to assignments submitted on Blackboard. The students received personalized notes and feedback from instructor that could be viewed by students on any computer with a web browser.

Results and Analysis

Thirty-three students (Electrical Circuits =18, Analog Electronics = 15) participated during the academic year 2007-2008 of this pilot project implementation. In classroom, students used Tablet-PCs for note-taking, working on assignments, accessing online material, submitting quizzes, problem-solving, and circuit design and simulation. In the beginning of the semester a pre-survey was administered to assess students' past experience and attitude towards tablet as a teaching and learning tool. Even though, more than 90% of students had never used a Tablet-PC before, it only took 20-30 minutes to get familiar with its use. Students were surveyed at the end of the semester to assess the impact of using Tablet-PCs and supporting tools (note-taking and CMS) in classroom. The survey results (N=18, Electrical Circuits course) on the usefulness (on a 5-point Likert Scale) of Tablet-PCs and NSS are summarized in Figure 6 and Figure 7 respectively.

As seen in Figure 6, 85% found Tablet-PCs useful for note-taking, 78% found it useful for classroom learning, 89% for circuit analysis activities, 100% for keeping class work organized, and 78% found it useful during lab experiments. As seen in Figure 7, 89% found that NSS improved their group collaboration, 83% said it improved their interaction in class, 94% said they paid more attention in class, only 44% said they asked more questions due to anonymous message feature of NSS, and 95% agreed that NSS helped in receiving immediate feedback.

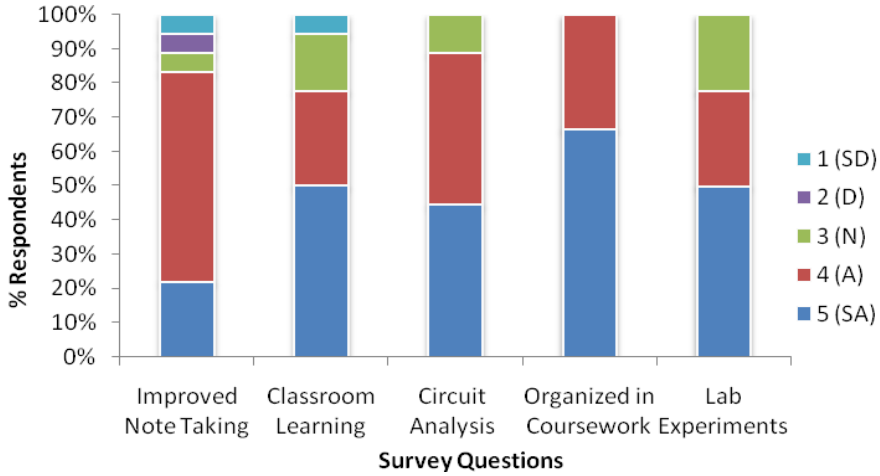

Figure 6: Student Responses to Usefulness of Tablet-PC in Classroom

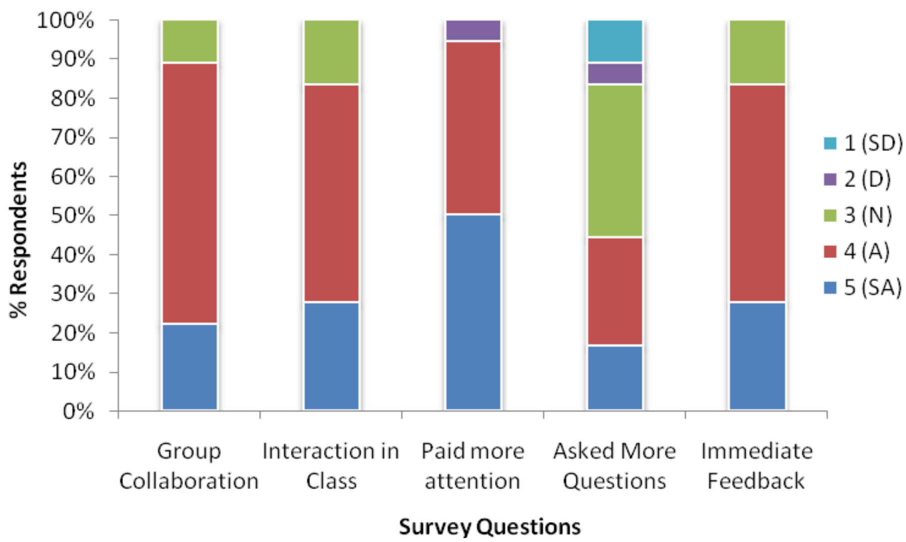

Figure 7: Student Responses to Usefulness of NSS in Conjunction with Tablet-PC

Figure 8 shows the average time of completion for two laboratory experiments in Electrical Circuits course. Results show that use of tablets in both classroom and laboratory significantly reduced the time it took to complete laboratory experiments. The availablity of lecture notes and online material at all times made it easier to complete laboratory experiments in shorter time. When tablets were not used, it took an average of 80 minutes and 94 minutes to complete RC Circuits lab and Passive Filters lab respectively. After use of mobile technology, the average time to complete these labs was reduced to 53 and 66 minutes respectively.

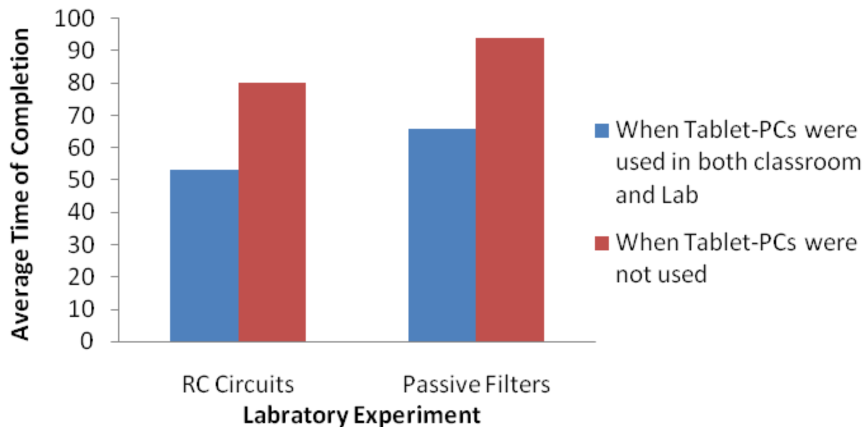

Figure 8: Average Completion Time for 2 Laboratory Experiments With and Without Use of Tablet-PCs in Both Classroom and Lab

The use of mobile technology in redesigned courses was also helpful in improving class participation. As shown in Figure 9, more than 60% of student in Analog Electronics course received a participation grade of 75% or higher. This was a significant improvement in classroom participation compared to when mobile technology was not used in the course.

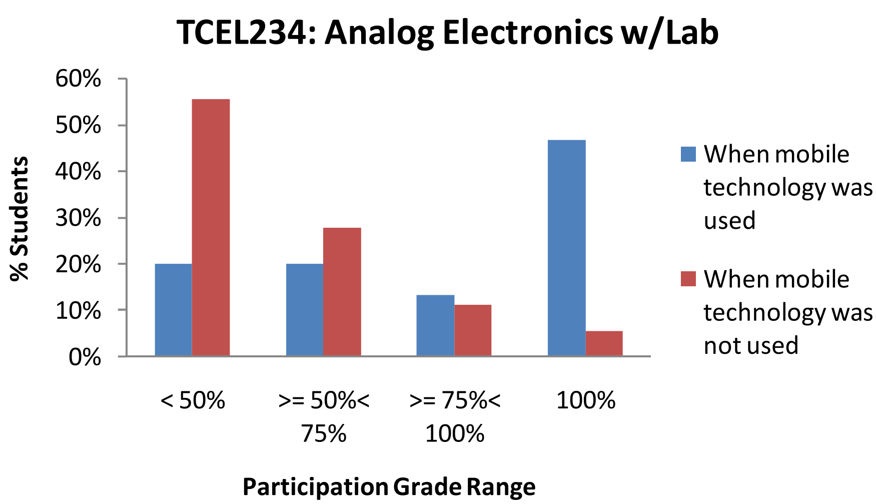

Figure 9: Participation Grade Range for Students in Analog Electronics Course With and Without use of Mobile Technology in Classroom

Conclusion

In this paper we discussed the impact of integrating mobile technology on classroom learning and teaching environment. The technology enabled classroom provided an effective an exciting teaching/learning environment for instructors and students alike. Mobile Tablet-PCs and supporting tools were used in two electronic circuit courses. These courses were redesigned to maximize the use of technology both during classroom activities and laboratory experiments. By making reading material available in advance, instructor was able to spend more time on group discussion and collaborative activities during class time. In addition, Tablet-PCs and supporting software tools coupled with wireless networking technology helped instructors in creating a flexible learning environment that improved interaction and student engagement during class sessions. Using digital ink capability of Tablet-PCs, students kept records of their learning process from the beginning, and steadily worked on them, rather than cramming all the work at the end. NSS improved the course delivery and monitoring group activities in class. The instructor was able to quickly poll students on any topic to assess their understanding. Instructor was also able to engage students in collaborative note-taking, thereby keeping them interested and engaged. Students actively participated in class discussions, and collaborative activities via technology resulting in better performance. Results from the pilot project show that students have expressed positive attitude towards use of technology tools in classroom environment and have found it highly useful for several classroom and laboratory activities. Results also show that student participation in both classroom and laboratory experiments improved significantly.

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Biography

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