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Integrating Laptop Computers into an Engineering Curriculum – Intervention and Teaching Strategies

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Introduction

An increasing number of universities and colleges issue laptop computers to incoming and current students. To successfully integrate laptop computers into course curricula, preliminary planning in multiple areas, such as infrastructure and faculty development, is necessary in order to form a framework for educational innovation and change. In addition, program and course curricula have to be revised to develop an integrated learning environment. This paper illustrates the planning efforts of Wentworth Institute of Technology and their effect on teaching strategies in engineering courses.

Institutional Background and Framework

Wentworth Institute of Technology is a four-year college, offering programs in areas such as architecture and design, management, computer science, engineering and technology. The Institute is committed to educational excellence and revisited its vision and strategic direction in the year 2000 to stay competitive in the higher education marketplace. As a result, it became evident that technical support and infrastructure should be expanded and technical services for faculty, staff, and students increased. After signing a contract with a consulting company, information technology services improved and state-of-the-art equipment was introduced to classrooms and laboratories.

Although Wentworth invested substantially in its infrastructure, it was noticeable that most faculty members did not fully utilize the new technical capabilities. Teaching strategies remained mostly the same, with a focus on the traditional methods and proven techniques with which professors felt comfortable. The gap between the type of content delivery and students' expectations grew and faculty members ran the risk of ignoring the shifting roles and responsibilities of 21st century teaching and learning.

In 2002, Learning Technology Solutions (LTS) was established as a division at the Institute to promote and support faculty members with the integration of learning technologies into teaching. LTS initiates faculty development programs and works closely with department heads and college administration to ensure the didactical sound execution of learning goals and objectives enriched through learning technologies. The quality of instruction is regularly captured through assessments and student feedback to evaluate teaching and learning and to consistently improve course outcomes.

In a quest to introduce new teaching and learning standards, multiple initiatives were launched on campus, such as the introduction of e-portfolios in first year courses and the integration of WebCT, a course management system, which expands the mode of delivery from traditional classroom settings to an online environment. To take advantage of these new forms of course content and to create and develop online materials, students were restricted to computer laboratories or personal computers in their dorm rooms. This was a significant limitation to instant learning and teaching opportunities in the classroom. Therefore in 2004, the Institute decided to pilot a laptop program with the Architecture Department, where all students from first to third year received laptop computers. The laptops and other technologies are initially isolated technologies and gain value in the teaching process only through pedagogically meaningful strategies. Therefore the pilot required changes to the curriculum to truly integrate technology into teaching.

Because of the success of the laptop pilot with the Architecture Department, all engineering and technology students entering Wentworth in the fall of 2005 received as part of their tuition an IBM laptop PC. The laptops included software that will satisfy the students' course requirements for the first two years of their program after which they will receive a new computer with updated software. They will take this second computer with them upon graduation.

The roll-out of the laptop program to all first year students placed departments, along with faculty members, in a beneficial position, because only the first year courses were affected. Therefore, a staged revision of the curricula could take place. LTS worked closely with program coordinators of the engineering programs to realize blended learning environments, which take advantage of both worlds - traditional classroom settings and online delivery - and which were directly tied to the overall program goals. Workshops and one-on-one consultations were offered to all involved faculty members to assure a smooth transition to the blended teaching model and to build technical competencies.

The following examples illustrate blended learning approaches within engineering courses focusing on content delivery, student-centered strategies, collaboration and hands-on education.

Integration of Learning Technologies into Engineering Courses

Presently, faculty teaching engineering courses with an abundance of equations, diagrams and figures are unsure that such courses lend themselves to using a different delivery system and newer technologies than the standard “chalk and talk” method. Although they realize that other disciplines, such as architecture and art history, are easily suitable to deliver online course related material and to engage in online discussions. Many engineering faculty do not believe these same teaching methodologies readily apply to engineering courses and appear to be susceptible to the phrase “You teach the way you were taught”. Students entering college, however, are extremely comfortable with using new and different technologies and want to see them applied to their engineering courses. Faculty teaching engineering need to find ways to implement different technologies to assist students to better understand difficult concepts more easily, to allow students to review material as needed, to expand classroom discussion, to better integrate classroom theory with laboratory experimentation, and to allow graduates of the programs to use the technology seamlessly. Since only first year students received the laptops, efforts were concentrated with these students and more applications integrated each succeeding year.

In fall 2005 laptops were used for the first time in the ‘Introduction to Engineering’ course, which is a required four credit course in the Electromechanical Engineering program. Students in this course were able to obtain all course material, course assignments, submit assignments, complete exams, link to professional society web sites, begin building their e-portfolios to be used for future co-op and career positions, and use their PCs for preparing their team’s classroom presentations. In addition to the scheduled classroom meeting times, this course also has two other components: (1) four laboratory modules and (2) a mentoring component with the program’s fifth year design students. One of the laboratory modules was an introduction to engineering graphics. Since the laptops came with two computer aided drafting software packages, students received the basic skills in the lab but did not have to return to a computer lab to complete or submit their assignments, thus allowing students to finish projects in their dorm rooms at times convenient to them. It also allowed the faculty member to review and comment on portions of the assignment if asked by a student without the need to set up an appointment. Part of the electrical engineering lab module required students to use sensors to measure physical quantities (temperature, pressure, acceleration, etc.) and analyze the data from any point on or off campus. The laptops have data acquisition software which easily allowed this assignment to be completed and showed students how field engineers accomplish their tasks. The mentoring portion of the course allowed seven to ten first year students to collaboratively work on a weekly basis with a fifth year design team. The first year students were able to take notes, contact vendors, assist on the design, as well as prepare and upload weekly memos to their faculty advisors by using online information and communication technologies.

In the spring semester, first year students used their laptops in the ‘Introduction to Engineering Design’ course. This course introduces students to the design process and how to go from a statement of a client’s problem to completed prototypes. Design teams

then must prepare and give a formal presentation. Students used their laptops for MS Project, obtained manufacturer's data sheets and application notes, took measurements, imported the data into a spreadsheet and prepared weekly memos as well as their final presentation in digital format. Because of the laptops, all student activities could take place seamlessly in one environment and could be shared between the members of the project teams and all other students in the class.

Overall the curriculum development had profound impact on the different roles of faculty members and students, which led to an ongoing modification on how course contents were approached and organized in a student-centered fashion, and teaching and learning styles and strategies were altered.

Conclusion

The effective implementation of learning technologies in general, and laptops in particular, requires a preliminary framework of infrastructure and faculty development as important starting point for blended learning. To enhance teaching with laptops and to improve student outcomes, it is indispensable to take a close look at existing course curricula and pedagogical strategies to create a meaningful teaching and learning environment. The permanent integration of student feedback and ideas over the course of the semester is beneficial to close the gap between students' expectations and instructors' perceptions and to evolve to a continuous learning experience on both sides.

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