

Engineering Students' Perceptions of Mobile Learning

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Abstract—Mobile learning programs have been developed to create ubiquitous online learning environment. Given the infancy of many programs, there is little understanding into what aspects of the program provide value to faculty and students. This paper focuses on the value proposition for engineering undergraduate students in a mandatory, comprehensive mobile learning program. Results indicate that the value proposition for engineering programs and liberal arts programs are significantly different. A need to better communicate the true value of industry specific software and skills acquisition is also highlighted.

Index Terms—Mobile Learning, Laptop, Undergraduate Engineering, Student Perceptions

I. INTRODUCTION

There are an increasing number of universities and colleges implementing mobile learning initiatives in the form of requiring students to have laptops for learning. These initiatives are motivated by increased market demands for graduates who are technology literate and have strong competencies using computers [1]. Such technology skills are particularly important for fields such as engineering, computer sciences, and business where graduates will be expected to integrate their theoretical knowledge with computer applications immediately upon graduation. Although many universities and colleges have initiated mobile learning programs, there is no widely accepted model for such programs. Currently, most initiatives are only for specific programs or levels of study. Only a small percentage of campuses have initiated such programs campus wide [2]. The majority of schools with mobile learning programs require students to own laptop. A small number of schools, including the University of Ontario Institute of Technology (UOIT), lease the computers and charge the students a fee for their use.

A number of qualitative studies have described the implementation of mobile learning programs at various institutions [3, 4, 5]. The majority of these studies have been focused on liberal arts applications [5, 6] although a few [7, 8] have analyzed a course or year of study in engineering or computer science. These studies have focused on describing the implementation plans and in explaining faculty and

student concerns related to the implementation. A number of studies have also examined how students are using the laptops for learning in terms of enumerating the use of basic software applications such as word processors, e-mail, web browsers, and spread sheets [9]. The learning and problem solving ability of students appears to increase with the integration of laptops in to the curriculum [10] but if students are not actively engaged in using the laptops during the class then they can become distractions and inhibit high quality learning [11].

Students have expressed a belief that laptops are important for learning but that the mobile learning programs do not offer sufficient value for their investments [12]. Given the cost of laptops, particularly for the lease based programs, students are concerned that they receive value for their investment. When they consider the costs for the mobile learning fee and the cost of purchasing a laptop on their own, the difference must be justified.

This study aims to identify elements that define students' perceptions of the value of a mobile learning program after five years of operation. We will consider students' perceptions not only on the impact on learning but also on the technical elements such as hardware, software, and support offered as part of the program fee. This will be the first study known to the authors to compare students' perceptions of value between engineering and liberal arts programs. It is important to understand the unique needs of engineering programs due to the intensity of software use and high-end computing needs required by students to support their design work. By gaining a deeper understanding into students' perception of value from the mobile learning program, the major obstacles to student satisfaction can be identified, and appropriate changes to the model implemented.

II. RELATED WORK

A. Implementing Mobile Learning in Undergraduate Programs

According to [13] as of June 2008 there have been at least 243 universities or colleges worldwide that have at some time. Many of these programs are limited to some subset of students such MBA students, Law students or Med students. Based on non-scientific analysis of the data provided, less than 10% of schools are attempting a program that requires all student to have a laptop, and most of these program simply required the students to have a laptop and do not manage a leasing modeled mobile learning program. The majority of refresh cycles for leasing programs is two years [7].

Some of the advantages of leasing models include a wider variety of support services, a greater selection of supplied

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software, reduced compatibility issues, and minimizes the total costs to students [7, 14]. These improvements are derived from campus wide licensing, bulk purchasing of laptops, and the standardization of classroom equipment [8].

B. Impact of Laptop Use on Student Learning

The results of laptop programs have been mixed [15]. While some studies [16] find that faculty and students believe that technology-enhanced laptop programs significantly improve student learning. In particular, [17] found that 81% of students thought that laptops were critical for the success at college. [16] found that students in Engineering found that IT-based learning and laptops were valuable tools in the education process. These students felt that the laptop enhanced teaching significantly improved their learning process. On the other hand, [11] empirical found that the use of laptops was negatively related to academic success. It should be point out that in [11] study students were given the option to bring a laptop where as in the studies such as [16] the mobile learning programs were standard and required for all students in the course/program.

Since most of the models do not require standardizes advanced software packages for all students, the ability for students and faculty to fully integrate the technology into teaching of the curriculum is limited. Many professors have expressed concerns about the ability to adapt to the technology-enhanced environment and to find appropriate software or computer assisted instruction material to support mobile learning initiatives [18]. Requiring all students to have ubiquitous access to the necessary software and technology to complete labs and assignments allows students greater flexibility and time to explore the design and problem solving processes of a course or program. Similarly, being able to access such materials in class allows professors to engage all students through active knowledge construction using the technology moving away from traditional passive lecturing methods [8].

III. MOBILE LEARNING AT UOIT

The decision to implement a mobile learning program was made before the university first opened in 2003. Located just outside Toronto, Canada, UOIT is Ontario's only laptop university, as well as one of the newest universities in Canada. UOIT does not have a traditional arts faculty but focuses on professional and technology related programs [19]. For the past five years, UOIT has been increasing its program offerings and recently has begun to offer select graduate programs in engineering and information technology security. Currently, there are approximately 5100 undergraduate students and 60 graduate students on campus. The majority of the students commute from home. Some student travel as long as 1.5 hours each way in order to attend class. From UOIT's inception, using technology to enhance teaching has been the mandate of all faculty members hired providing UOIT a competitive advantage in the market.

All buildings were designed to include wired connectivity and power connections to every seat in the classroom. The entire campus is also wireless connected. This provides redundant connectivity for every classroom seat. Class sizes and tutorials range on average between 35 – 80 students.

Some core courses for general program requirements reach sizes of 200 – 250 students. Faculty members and teaching assistants are provided with tablet computers to integrate the technology into all elements of teaching on campus.

A. Mobile Learning Program

The mobile learning program at UOIT is structured so that all students are required to lease a Lenovo ThinkPad. Every year, all the software required for a students program is loaded on their machine. The base image includes the Microsoft Office Pro suite, web browsers, virus protection software, iTunes, SPSS, and Adobe Acrobat Pro (mobile learning). Each program then supplements the software on the laptop with industry and program specific requirements which could include business simulations, CAD programs, Matlab, Maple, or ChemOffice Ultra. Any package that an instructor will integrate into the curriculum is included on the students' machine. This allows for a higher level of technology-enhancement of learning as students are provided access to most of the leading software used in industry.

Students also have access to a mobile computing and IT support centre for all hardware and general software related questions and on campus repairs. There is also a loaner laptop service for laptop repairs that require extensive maintenance. Insurance for damage and theft is also included in their mobile learning fee. The mobile learning fee also includes all other technology related campus fees such as infrastructure for network support, printing services, and even PDAs for 4th year nursing students on practicum placements.

The objectives of the mobile learning program are to provide all students with equal access to technology. The use of mobile learning devices should support increased interaction between students, faculty, and administrators. The mobile learning program enhances a student's ability to participate in self-directed learning and to make technology ubiquitous throughout the learning experience. The advanced technology skills developed by students will provide them with a competitive advantage in the market upon graduation. This has already been demonstrated in the graduate hire rates in education that are five times the provincial average after two years of graduation.

The laptops are exchanged every two years with students purchasing their laptops at the end of the program for \$1. The mobile program fee for students it one of the higher fees [13] at \$1350 per year for liberal arts type programs such as education, business, and criminology, and \$1530 per year for technology heavy programs such as IT, science, and engineering [13]. Given the large fees associated with the program, there currently is a student perception that they are paying too much for the program.

B. Use of Technology in Undergraduate Engineering

The Faculty of Engineering and Applied Science supplies a large variety of software to its students through the laptop program. The faculty receives a number of software applications through Partners for the Advancement of Collaborative Engineering Education (PACE). PACE is a partnership between General Motors, EDS, Siemens, HP, SUN and Autodesk [20]. In addition there are eight other contributing companies and additional PACE supporter

company [20]. PACE supports engineering program at over 45 universities throughout the world. Through PACE, UOIT has received hardware and software worth over \$680 million [21], the majority of which is software for the laptop program.

In order to support the increasing requirement of employers for advanced knowledge and skills using design software [22], every student in engineering based programs is provided the opportunity to master technology-based tools focused on the process of engineering design. A strong focus on design principles supported through technology is a guiding principle in all engineering programs.

Throughout the courses of the engineering degrees, the use of software application is included in many aspects of the educational practiced. For the 2008-2009 academic year the Faculty of Engineering and Applied Science is requesting over 75 software applications. When the individual options for various applications (such as Matlab Toolboxes) are considered, over 125 different items need to be purchased for each engineering laptop. Students use software to prepare for labs, complete assignments, and in some course even to do exams. The continuous availability of software to the students allows the instructor to expect more familiarity with the software, and gives the students the ability to learn software in more ways and become familiar with feature beyond those that the courses require.

The students' laptops in many cases act as a portable lab. Through the use of simulation software packages, students are able to complete experiments that have traditionally been done physically in teaching labs. In addition, some courses provide hardware kits, such as Lego Mindstorms, that students are then able to program anytime anywhere for major course assignments. Continuous access allows students the ability to get more familiar with the intricacies of the systems as they have the hardware and software that they need.

Within the faculty there is a pilot project underway to test the use of convertible tablet laptops as a tool to increase the abilities of students to complete engineering design assignments. This pilot is looking to find technologies that can increase a student's ability to learn the process of engineering design so that they are more prepared to use the skills that they have learned when they join the workforce. It is hoped results from this research will aid in improving students' ability to complete real-world engineering problem solving and design.

IV. METHODOLOGY

In order to determine how students perceived the value of the mobile learning program, a survey was created based on input from students, faculty members, and IT help desk and support staff. The survey consisting of 69 questions on all aspects of the mobile learning program. Demographic questions were asked at the start of the survey such as sex, length of time at the campus and faculty association. Both open ended and Likert scale questions were asked that related to all areas of the mobile learning program including the perceived value of software, hardware, help desk support, insurance coverage, use of technology in the classroom, and printing services. The participants were also asked to discuss

their view of laptop control/lock-down during classes as well as in class distractions from the laptops.

Students and faculty members from across campus were asked to complete the survey through posters, fliers, classroom presentations, posting in the learning management system, and through the creation of a Facebook group. As an incentive to participate in the study, participants could enter their email address for a chance to win an iPod Nano. This resulted in 883 participants (18% of the UOIT population) with significant representation from all years of study and faculties on campus. The distribution of participants by faculty was: 281 from the Business and Information Technology, 90 from Criminology and Justice, 63 from Education, 118 from Engineering and Applied Science, 47 from Energy Systems and Nuclear Science, 109 from Health Science, and 104 from Science. The specific distribution of engineering students by year of study was: Year 1 – 50, Year 2 – 24, Year 3- 21, and Year 4 – 21.

V. RESULTS

A. Students' Perceptions of Mobile Learning

80% of students in Engineering at UOIT rate the value of the mobile learning program as significant or very significant. The mobile learning program was an influencing factor for 65% of engineering student when they were choosing to attend UOIT. Engineering students also view the mobile learning program as an important part of their educational experience at UOIT. Over 86% of engineering students ranked the mobile learning program as significant or very significant to their learning at UOIT. As can be seen in Figure 1, the percentage of student who perceived the laptop as very important is significantly higher for engineering and IT programs than in programs in the liberal arts such as Criminology and Justice.

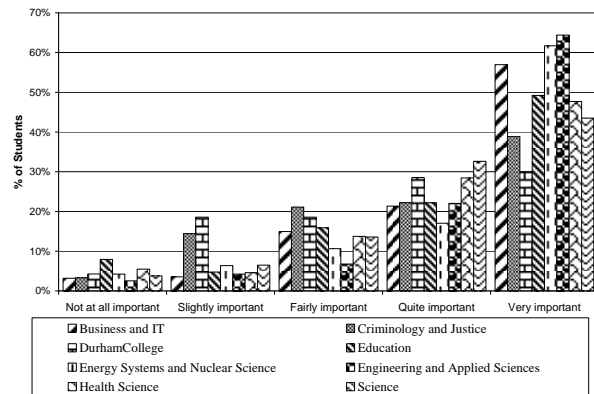


Figure 1 - Perceived Value by Faculty

While the students were very positive about the program overall, there were some aspects of the program that were not as positive. Only 65% of students felt that their professors were either Good or Fair in their use of the laptops for teaching. Students are concerned that the professors are not making use of the laptops during the times that the student is at in class with the instructors. Some commented that professors are not fully utilizing the laptops and that they are disappointed by that the professors do not fully utilize the capabilities of the laptops to provide the best educational experience.

While there is a general concern among faculty that students are distracted by the technology during class and that this affects other students, more than 75% of students did not mind other students using their computers for non-class purposes during class. Student commented that they are being required to pay for the laptops, they should have the right to use them when they wish.

In addition to the concerns about the professor's use of the laptop computers, there was an even less positive response about the teaching assistant's use of the laptops. In the survey, teaching assistants' use of technology was rated Fair or less over 61% of the time. Until 2006, UOIT's engineering faculty had no graduate students and did not have a fully operating program until September 2007. Since there were no graduate students, teaching assistants were hired from the general community around the university and from other universities in same area. This meant that teaching assistants were being hired exclusively based on their abilities to support the course. Since the start of the graduate studies program, there has been a shift to attempting to fill all teaching assistant positions with graduate students. This change means that students with only a minimal knowledge of the software being used to support the course. In the 2007 – 2008 academic year most of the teaching assistants for the course that placed a significant require on the knowledge of CAD software were selected from the graduate students who completed their undergraduate engineering degrees at UOIT. The vast majority of graduate students not from UOIT's undergraduate program had either a very limited knowledge, or no knowledge, of the applications being used and therefore significantly less knowledge than the undergraduate students who had only completed one engineering course at UOIT. This problem will be especially pronounced in third and fourth year courses as there will be a need for teaching assistant with advances knowledge of software that simply will not be available from the faculty's graduate students from undergraduate programs outside UOIT.

Another major area of concern was the reliability of the LMS that the university requires that all courses use. The LMS reliability was important or very important to more than 85% of the engineering students. The LMS is often use as the primary method of communication with professors outside of the classroom. In addition, most courses use the LMS to provide assignments, laboratory instructions, and other announcements. Students simply expect it will be there when they need it.

The survey shows that students do not have an accurate understanding of the value of the software that is being provided to them through the mobile learning program. More than 53% of student fell indifferent about the value of the software, or that the software provided was of little or no value. Students commented that they would rather buy the required software themselves or simply download "free" from the internet. The perceived value of the software provided to the engineering student was lower but as can be seen in Figure 2, liberal arts students in the Criminology and Justice program had an even lower opinion of the value of the software with more than 73% having an opinion of indifferent or less when asked about the value of the software provided. For the students in engineering programs at UOIT,

an estimated annual value for the software on each students laptop exceed \$500,000 when averaged out over a four year program and the retail price for the software as provided in any year would close to \$1 million.

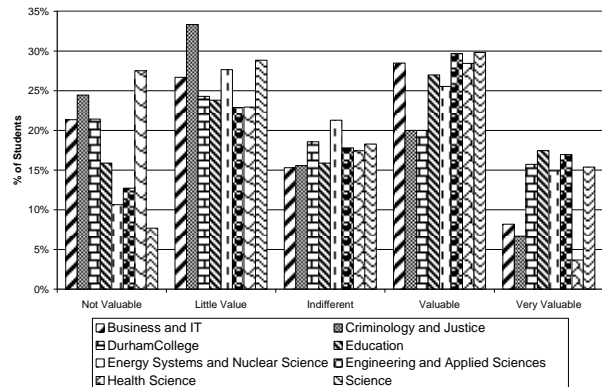


Figure 2 - Perceived Value of Software

The attitude towards the software value fits with results of a survey release in early 2008 that have been commissioned by Symantec. The survey document that millennial workers (those born after 1980) have very different attitudes towards technology compared to older workers [23]. This shift is still being felt in university such as UOIT where the laptop program is highlighting the way that these students view the technology. In the survey, over 86% of students responded that they should not be limited only to academic resources while on the campus network. Students' comments about this idea were extremely strong. The students express that what they used the network for was not anyone else's business and that anything that interfered with this was a violation of rights to do what they wanted. The students were also aware that while the idea of limiting access to academic resources sounds possible it would be difficult or impossible to prevent.

Student often suggest that for the money they are paying for the mobile learning program that they would be able to buy a better laptop. They will sometime even allocate a small amount for the software but do not look consider the infrastructure that supports the use of the laptop. The entire campus at UOIT is covered by a wireless network system to give students access to network resources regardless of location. This service is partially funded out of the mobile learning fees and not included in students' analysis of costs. Another way in which the university supports the laptops that is not considered by students is through the annual re-imaging process where students are provided with the latest version of system which have been tested to ensure that they are fully functional. Finally, UOIT provide a full helpdesk for all problems with equipment provided through the mobile learning program. This support includes full hardware repair services on campus and loaner laptops to ensure that student are not place at a disadvantage by not having access to a laptop at a time when they need to have access to one. Although the majority of students use this service at least one, they do not consider the commercial costs associated with having 24/7 support available.

B. Students' Perceptions of Obstacles Limiting the Value of Mobile Learning

A major challenge to the mobile learning program is

demonstrating to students that the program is worth the additional costs they are required to pay. A number of different factors impart the perceived value of the program. For engineering students the performance of the computers is a major concern. This is in contrast to laptop programs implemented in liberal arts programs which tend not to place so many demands on the machines.

Engineering students at UOIT place significant demands on the laptops they are provided. Applications such as Siemens NX 5 place significant demands on the laptop's video system. The video adapters in these computers are some of the best adapters commonly available for laptops but only meet the minimum specification for NX 5. Other applications such as Matlab and NASTRAN program require high processor and memory speed. Laptop hardware limits the ability to get faster memory or faster processors due to the physical and heat dissipation constraints. As a result of these demand, the majority of engineering students experience 3 or more performance issues each week. The challenge for the UOIT mobile learning program is to find a balance between performance and cost. While the number of performance issue could be reduced, the increase in cost to the students would be significant and would not necessarily improve the perceived value of the program.

Another obstacle that limits the perceived value of the mobile learning program is hardware and software reliability. More than 78% of engineering students experience at least one application crash each week. This is despite the testing completed on the machines prior to deployment. The challenge for UOIT is that the students are given full control of the laptop and are able to install any application. Many students take full advantage of this and install a large variety of applications that IT has not tested. The students have clearly stated that they want the ability to install applications on the machines so application crashes will continue to exist.

The physical screen of the laptop is another issue that students identified as being a common problem. In the last year 39% of students have need to have the screen on their laptop repaired. UOIT does not currently have statistics that track whether the screen problem was the result of a hardware malfunction or as the result of the treatment of the laptop by the students.

Battery reliability has also proven to be an obstacle to the student perception of value of the mobile learning program. 39% have had issues with the reliability of the batteries in the last year. Most of these issues (more than 90%) were machines in their second year of use. It appears that the ways that students use the laptops are wearing out the batteries faster than the traditional business user.

For some engineering teaching labs desktop computer have been installed even though all students have laptops. These computers have generally been installed to provide an interface to special hardware that is being used in these labs. The existence of the computers diminishes the perceived value of the laptop program but in many cases cannot be avoided. Since many manufacturers of lab equipment assume that there will be a desktop computer available, they implement their interface using cards that fit in these units that cannot be connected to the laptops. To maximize the perceived value of the program, the use of desktop

computers, and traditional on campus labs need to be kept to an absolute minimum.

An area that seems to have a significant impact on the students' perception of value of the mobile learning program is the actual use of the software in their entire educational experience. Faculty member routinely require the use of technology for completing assignments but are not as good at integrating technology into their teaching. Some faculty members only use of technology is that they present during their lectures with PowerPoint. To the student this is not a value added since that is now considered to be the normal way to do a presentation. Students want to make actual use of their laptop during class through interaction or the ability to follow along or try something during the lecture. This issue is not a technical issue that can be solved by the mobile learning program itself but that requires leadership and support from senior university administration to ensure that the faculty have clearly outlined expectation of what instructing in the mobile learning program means and constructive feedback on when and how they need to improve.

VI. RECOMMENDATIONS FOR MOBILE LEARNING PROGRAM

Based on the results of the survey, students in the mobile learning program need to be educated about how the program is more than just the laptop hardware. The software provided as part of the program is a significant contributor towards the value of the program. This is especially true for engineering programs where the value of the software provided has a commercial price many times larger than the cost of the actual laptop.

Mobile learning programs need not only to communicate the general benefits of the program to all students but provide faculty (and possibly program) specific details of the actual value of the mobile learning program to those students. The details of the value of the software provided to engineering students will allow the student to better understand what they are getting for the investment they are making. This will encourage students to place more value on the software when they consider the value of the mobile learning program.

Another way that the mobile learning program can increase its perceived value is to increase the use of laptop into the actual learning experience. To accomplish this more support and incentives need to be provided to faculty members in order to get the technology fully integrated into both the curriculum and the teaching practices of the faculty members. This integration would allow students to make more use of the technology provided by the mobile learning program in more aspects of their education helping their belief that the mobile learning program is a value to them.

Mobile learning programs must be designed based on the type of program that they are supporting. Liberal arts and business program general use a very limited set of software and these applications are either free or relatively low cost. In addition they do not change significantly over the 4 years of typical degree. In comparison, engineering and information technology program tend to use all the applications used in the liberal arts program but also use a much large set of applications. These specialized applications tend to be much more expensive and change or are updated at least annually. In addition to the cost, many applications require much more

power and current technology to operate correctly. Because of the highly complex needs of engineering and similar programs, a school-managed program is the best or only way for a mobile learning program to completely support the use of laptops in engineering and other technical programs. Liberal arts programs on the other hand can manage to operate successfully with a more flexible program. In addition, the use of a standard laptop to support both programs will likely result in a laptop that is too powerful and expensive being provided to liberal arts programs. It might also lead to a less than optimal product for all programs if compromises are forced to find a single laptop for all programs.

Finally, the model of using graduate students as teaching assistants for laptops program needs to be reviewed. Traditionally, the knowledge and skills of a graduate student in a specific field were sufficient to provide a good level of support to undergraduate students. In the mobile learning program, the knowledge of a specific field is only a starting point. The graduate students need to be fully competent with the software applications being used so that they can fully support the students. This may require that teaching assistants be hired from outside of the students in the graduate studies program in order to provide a good education experience to the students taking the courses.

VII. CONCLUSION AND FUTURE RESEARCH

The mobile learning program at UOIT provides a significant amount to the student, but the students are not fully aware of this value. This needs to be overcome through better marketing of the program, better integration of the technology into all aspects of the students' educational experience, and an increased reliability of the laptop hardware and/or service levels that ensures that students are not inconvenienced by hardware issues.

The effects of the program on graduating students' ability to better find jobs and provide immediate assistance to their employers is not yet fully understood as there have only been 2 graduating classes as of June 2008. There is a need to follow-up with these students and future graduates to find out if the skills they acquired through the mobile learning program provided them a benefit as they entered the workforce. In addition to the perceptions of graduates, the perceptions of employers of UOIT graduates need to be studied to better understand the complete impact of the mobile learning program.

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