COMPUTER LITERACY IN AN INTRODUCTION TO ENGINEERING COURSE FOR FRESHMAN ENGINEERS

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Abstract

Like most colleges of engineering, the J.B. School of Engineering has increased its expectations of students' computer literacy in recent years. This is highlighted by the decision in 2007 to require incoming freshman to purchase a Tablet PC. Survey data from 2008 indicated that this was the first computer ever owned for 42% of freshmen surveyed. With the Tablet PC requirement, the J.B. Speed School of Engineering also adopted the collaborative learning system (CLS) DyKnow®, which is Tablet PC specific classroom software. More recently the Department of Engineering Fundamentals has begun adopting the use of on-line multimedia textbooks with active content, such as algorithmic homework problem generators with built-in systems for immediate help and grading. Though there are many students with excellent computer skills, the requirement that all students use DyKnow, a Tablet PC, and on-line course content, has made it clear that all engineering students lack the level of technical computer literacy needed to effectively participate in some Engineering Fundamentals courses. The J.B. Speed School of Engineering has also recently created a new required course offering: *Introduction to Engineering*. This course has many components, including software and Tablet PC use; making this course ideal for addressing the computer literacy shortcomings of the students.

The authors have been working for several years developing computer literacy content for the *Introduction to Engineering* course. This paper discusses the content developed, pedagogical motivations for the content and its delivery, observations and challenges in this delivery for computer literacy for engineering students. There are two competing elements in this problem; improving student computer literacy, and decreasing the faculty effort required to overcome initial hurdles many students face. Due to many factors, a percentage of students arrive with a level of computer literacy that exceeds what can reasonably be expected of all students. Therefore, a base line of computer hardware and software literacy is currently under development, and instructors continually work to move students to that level. This paper provides a taxonomy of the computer literacy components required for engineering students to succeed, and offers justification for these components, as well as identifies challenges. A key observation that has yet to be adequately addressed is the disconnect between students' perceptions of their computer literacy (often very high) and their actual computer literacy. This disconnect can frustrate both students and instructors, and also disrupt learning. Even with the vast computer literacy improvements over the years, there is still much that needs to be addressed. However, given the short amount of time allotted, students in the course (400+) do generally achieve a sufficient level of technical literacy in a very short time (one week), but there is much room for improvement. Going forward, the authors expect that developing a taxonomy and formalism will lead to improved teacher efficiency and student computer literacy.

Introduction

The personal computer, telecommunications, and information technology have arguably had a large transformational impact on people's lives over the past 15 to 30 years. Increasingly, these technologies are having a similar transformational effect on post-secondary education, including engineering education. The increase use of computer and information technology in

engineering education presents both challenges and opportunities. As Gumport and colleagues discuss, there are large issues at stake, and there is not universal agreement about the potential benefits technology can have for education.[1] Tablet PCs are a recent example of computer and information technology that can, and likely are already beginning to, have such a transformational effect.

The University of Louisville's J.B. Speed School of Engineering introduced a Tablet PC requirement for the incoming students in 2007. This was the first year for a computer requirement of any sort for the engineering students. Entering freshman in 2008, 2009, and 2010 have also been required to purchase tablet PCs. This program was enacted due to the fact that Tablet PCs can be beneficial to students learning, as long as the technology doesn't become distracting. There are many papers detailing student use of tablet PCs in the classroom and some on using a tablet PC to present a class.[2,3,4,5]

Computers and information technology were certainly present before the adoption of Tablet PCs, but because there was not a Tablet PC or notebook PC requirement, there was a strong dependence on general and specific computer labs to provide access to specifically required resources. With the Tablet PC requirement this is no longer the case and, therefore, there has been an increased adoption of other "information technology" components for courses. These components include: on-line, multimedia, textbooks, collaborative learning systems (CLS), and the use of web based interactive homework for engineering analysis (through a system called MyMathLab from Pearson publishing[6]).

These trends have highlighted the fact that students arrive as freshmen with a wide range of computer and information technology competencies. The requirement that all students use the CLS DyKnow, has made it clear that most all engineering students lack the level of technical computer literacy needed to participate in courses that make use of these technologies. This paper discusses the authors' experiences in identifying and understanding the deficiencies and their work to address these deficiencies in the required freshman *Introductions to Engineering* course. This course has many components, including software and tablet PC use, and these components make it ideal for addressing the technical literacy of the students.

Background Information

Gumport and Chun give three general areas of higher education that are potentially impacted by technology: the nature of knowledge, the process of teaching and learning, and the social organization of teaching and learning.[1] They accurately point out that within the context of the nature of knowledge, there is now a direct impact on the "nature" of what it means to be educated (post-secondary). Being "educated" now includes computer literacy, despite the fact that the rapid pace of changes in technology makes it nearly impossible to define precisely what is meant by computer literate. This is even more so for engineers, with expectations generally higher than the norm.

In coinciding with this expectation, the infusion of technology into people's daily lives has led many to conclude, without a lot of evidence that younger students who have grown up surrounded by technology have an innately high level of computer literacy. Many even suspect that incoming freshmen from the "Internet generation" know more than their college faculty about computers and information technology.[7] If this were true, then the adoption of Tablet PCs and the use of e-books, CLS, network licensed advanced engineering software and the university's wireless network should present little challenges for students. Students tend to believe this is true, and typically self-report a high level of computer literacy.

However, Ohio State published results that only 9% of their incoming freshmen class of 2000 passed a three-part proficiency test.[8] The three parts of this proficiency test cover (a) In-

ternet Tools, (b) Searching Skills, and (c) Research Techniques. This test also supports the fact that students use today's technologies, but they don't always have the ability to discern valid and trustworthy information from opinion or even false information.[9] Furthermore, in a survey conducted at the University of Louisville, in fall 2008, 42% of the freshmen engineering students indicated that their Tablet PC was the first computer they had personally owned.[10]

This data supports the authors' conclusion that increased incorporation of computer technology in the classroom requires that all students have or develop a suite of computer literacy competencies that have previously not been universally required. It is especially the case when more and more of the technology (Notebooks, Tablet PCs, Tablets (Android or iOS based), Phones, Clickers, and e-Readers) is owned and maintained by students. Furthermore, it has been the authors' experience that incoming freshman lack the requisite level of computer literacy. The J.B. Speed School of Engineering is like many other universities and is trying to combat this problem through the use of freshmen courses designed to improve critical thought regarding computer technology information.

All incoming students to the J.B. Speed School of Engineering are required to take the *Introduction to Engineering* course. The goals of the course are to introduce the new students to college campus life and resources, make the students aware of the different disciplines of engineering that might interest them, give them a feel for what engineers do, and introduce them to their Tablet PCs and engineering software that they might use in school or profession to solve technical problems. The next section covers the computer literacy goals for the students in this course.

Computer Literacy Goals for Freshman Engineering Students

Since its inception, a component of the *Introduction to Engineering* course has been to acquaint students with their Tablet PCs. The authors have been developing computer literacy content for this course for several years. There are many issues to developing computer literacy for students. Two issues that are in conflict are improving student computer literacy, and decreasing the faculty effort required to help students over some initial hurdles.

There is also a student disconnect that needs to be addressed, since in a 2008 survey 71% self-rated themselves as above average or very skilled with technology. A repeat of this survey with the incoming freshmen in 2010 had 70% self-rate themselves as above average or very skilled. This disconnect can frustrate both faculty and students and even hinder learning.

The *Introduction to Engineering* course has dedicated the first four hours of class meetings to help students reach a sufficient level of computer literacy. The Engineering Fundamentals faculty began discussing what the most important technology topics were to cover for the incoming freshmen. The topics were chosen based on the technology and computer needs for the common courses that all freshmen take their first semester from the Department of Engineering Fundamentals, which includes engineering based calculus, as well as the *Introduction to Engineering* course.

In developing the computer literacy content for this course, the authors have begun to identify areas in which different pieces of the computer literacy belong. This has been helpful in both organizing, and prioritizing the developing instructional content. The areas currently identified are: (a) setup the required software and hardware; (b) use of the required classroom learning software and content management systems; (c) security and privacy; and (d) general productivity. The following sections elaborate on these areas and discuss specific cases.

Setup Required Software and Hardware

The increase use of technology at colleges and universities means that students have additional

responsibilities, with respect to being prepared and able to use or interface with these technologies. An excellent example of one of these technologies is wireless networks. Most colleges and universities use an authentication system, and connecting to these networks may require some system configuration before a valid connection can be established. Once configured, this process becomes almost transparent. However, connecting to a wireless network for the first time, or fixing connection issues are not common among the computer literacy skills of many freshmen. In the *Introduction to Engineering* course, the instructors guide students toward the instructions provided by the university's IT department. Instructors usually devote time to fix issues if they arise, an approach that we would like to change. There are without doubt other examples of items needed to use certain university computer resources: such as installing a specific browser to work with certain university systems, or disabling pop-up blockers.

This year, problems were experienced with 64-bit versus 32-bit web browsers and Java. These correlated to another example of software requirements and challenges as a result of using other tools in the classroom. Specifically, this caused issues for some students using additional software and websites required for their other engineering courses, and again highlights the challenges that arise when the use of technology is required. The complexity of today's computer operating systems and software assure that there will be unanticipated configurations that cause new problems in the future. Identifying and fixing these configuration issues is often beyond most students' abilities. Therefore, this past year, students were shown the difference between 32-bit and 64-bit Java and 32-bit and 64-bit Internet Explorer. Students were required to install both versions of Java due to the requirement of the MyMathLab software used in the Engineering Analysis (engineering based calculus) courses.

In addition to software requirements, Tablet PCs are one element from hardware requirements that is included in the *Introduction to Engineering* course. General knowledge of Tablet PCs is provided, including a general discussion of what are the major differences between Tablet PCs and laptops, and why Tablet PCs are useful tools in this environment.

Required Academic Software

There are now software and hardware packages that are heavily integrated into the classroom, and students must know how to use them effectively. This goes beyond just configuring a setting at the operating system level, such as wireless access. Students must be able navigate and customize these tools. An excellent example of this area is the literacy needed to effectively use a content management system (CMS) such as Blackboard, or even collaborative learning software (CLS) like Dyknow. DyKnow is a CLS that is based on a client/server model and is a partner in interactive education that combines sound teaching with intuitive software to create flexible and effective solutions for teaching and learning.[11] Since the J.B. Speed School of Engineering adopted the software in 2007, it has been important to train the students on how to best use the software. Most students are not familiar with CLS systems, and need help understanding how the CLS and classroom learning work together, and how to use DyKnow effectively. For example, the ability to have students submit their work in DyKnow is a commonly used feature. This is not difficult, but has required direct training to learn this task. If systems, such as DyKnow, become more common place, faculty will increasingly expect students to already be able to do these simple tasks (submit a panel, etc.) whenever they ask, without instructing them how to complete the task. Every class at the J.B. School of Engineering using DyKnow should not be responsible for teaching this information, and this is a significant motivator for the training of DyKnow in the mandatory *Introduction to Engineering* course.

Security, Privacy, and Data Backup

Security and privacy are pervasive issues today, and students need awareness in this area. Use of anti-virus is an obvious example, but also demonstrates the dangers of the lack of expertise, when students install malicious software under the impression it is genuine, or when they install multiple anti-virus programs. Students in *Introduction to Engineering* are required to install some kind of security anti-virus software.

They also need to understand the implication of hardware or software failure; losing the availability of a Tablet PC with all of their notes and work can have serious consequences. Based on the survey showing some students had never owned/maintained their own computer, the instructors felt it was important to also stress backup strategies and reasons. Real-world scenarios are mentioned where students are studying for their final exams, and have lost their notes due to hardware failure, theft, or accidental deletion. It was emphasized that this left the students scrambling to recover the course topics/information covered due to not having a good backup of the material.

General Productivity

This area is likely too broad to cover all possible topics for the class, but it is one of increasing importance. The overabundance of software that might help students is daunting. Calendar apps, Google docs, Mendeley Reference Manager, Microsoft Office, all provide potentially very useful abilities, and while students may use some of these software packages, using them effectively for class might be an area they lack. While students might have experimented with PowerPoint, they most likely haven't been required to develop a professional presentation. Our students have access to a software bundle, and in *Introduction to Engineering* they are required to install all the software on their Tablet PCs. Among the most useful of these software components are: Microsoft Office, Matlab, Maple, and DyKnow.

Microsoft OneNote, which many students may be unfamiliar with, is covered in more depth during the four hours of computer technology instruction. Microsoft OneNote is simply a digital notebook. It is an integrated part of Microsoft Office, but it is also offered as a standalone program. It is useful for note taking and can be used to replace a regular paper notebook. However, to only treat OneNote as a paper notebook replacement would be missing some of the great flexibility options it offers. OneNote allows for freeform notes that are written or drawn on a tablet, images, documents, files from other Microsoft Office system programs, rich media content, and any other printable files. What OneNote doesn't provide is organization; rather it will let the user organize it in a way that works best for them. The instructors offer some ideas on maintaining organization, and how to get the most out of utilizing OneNote.

In *Introduction to Engineering*, a portion of the second day of the course is devoted to best practices dealing with and using Microsoft Windows. Elements discussed in this lecture include Windows Journal, Windows Snipping Tool, different web browsers and plug-ins, and PDF creators. These topics are items that instructors and teaching assistants have either noticed students having problems with or things they find useful, and are very likely to change from year to year.

Conclusions and Future Directions

Raising freshmen computer literacy to a reasonable level to succeed in their courses has been successful since introduced in 2007, although there still is a need for further improvements. Instructors have discovered that this course must remain flexible and deviations year to year are encouraged. Because of the evolution of technology, course material is constantly in a state of flux, and must be reviewed for relevance each course iteration.

A major improvement area that needs to be addressed is increasing the students' ability to

trouble shoot and resolve their own issues. Too often, when there is a problem, students want someone else to fix it for them, or they claim something is wrong that is actually user error. For example, students will report DyKnow is not working, when the real problem is they are not connected to the network.

A future direction is to identify students who possess trouble shooting skills and see if there is a correlation between their retention and success in the engineering school. If there is a correlation, then a course of action can be adopted to try and provide more students with these trouble shooting skills to help them improve their success. Another direction to consider is harnessing the power of students helping students. The difficulty with this is preventing the ones who understand from just fixing the problem for their classmate, instead of showing them what the problem is and how to recognize and fix this problem in the future.

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