

TECHNOLOGY IMPLEMENTATION IN THE INTRODUCTION TO ENGINEERING CLASSROOMS

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ABSTRACT

The Introduction to Engineering courses offer students overviews on the engineering disciplines and other related industries. Such courses support hands-on and interactive activities to enhance the academic success in engineering studies. These activities are given in the classroom allowing the students to assess their effectiveness and benefits gained from the engineering success tools. Conventionally, such class activities require print-outs or workbooks to be archived in portfolios to be kept for future references. The main shortcoming of having the activities performed on printed papers is the contradictory message conveyed to the student when teaching them to uphold and maintain sustainability in engineering while a notable amount of papers is being wasted. Another disadvantage is the delayed feedbacks to the students which are usually returned in the next class meeting; however, every class meeting brings the students new activities and due to the slow response, the students are prone to make the same unlearned mistakes. The main objective of this work is to propose techniques that implement technology in the classroom to enhance the engineering academic success implementation online and on the fly. The proposed study suggests that all students need a laptop equipped with adequate software and tools to excel such pedagogical process. Fortunately, most of the activities administrated in the ENGR 100s classes can be easily made available electronically as Word document or portable document format (pdf) files. Although some of the used files need altering to allow electronic editing, implementing the activities online is still easier and faster than distributing papers. Furthermore, online interactive learning systems such as Blackboard makes the implementation, sharing and grading the work effortless.

Introduction

The implementation of technology in classrooms including computers and other smart devices is becoming more popular in many various educational levels. The impacts of such approaches are being argued by many researchers proposing different hypotheses as to how easy it can enhance the learning process, solving problems, sharing and documentation.

Supportively, Fisher & Waller argue that technology in classrooms help students develop vital skills needed for today's evolutions of technology and holds students to a higher level of academic expectations by requiring team-based and peer-to-peer interaction (Fisher, D., & Waller, L., 2013). Tubaishat et al proposed a study that recommends studying in technology infused environment to help students be independent in progressing and express their ideas enthusiastically and develop their communication skills (Tubaishat, A., and Bataineh, E., 2009). No doubt that research is a mandatory skill for engineering students and it is agreed that injecting technology in classrooms enables students to be more confident in such skills such as web searching and sourcing. In all cases, feeding the internet into the students' table reduces the need for students to leave the classrooms seeking supports from the library or other computer labs (Efaw, J. et al., 2004).

Hamre et al point out that computers in the classrooms improve student-teacher interaction by opening more communication channels, thus increasing the interaction availability (Hamre, B. K., & Pianta, R. C., 2005). Additionally, instructors' feedback often has a delayed mode which is resolved by providing opportunity for real time feedback with the availability of computers in and outside the classrooms (Greenberg, B., Medlock, L., & Stephens, D., 2011). One other aspect affected with the proposed work is note taking. Conventional chalkboard or whiteboards cannot preserve the teacher's comments and feedback from being erased at the end of the class (Waller, L., & Lumadue, R., 2011). The accompanying technology such as wireless network, drop box and multiple-projection allows students' work to be directly projected and commented on before the whole class who can observe

and elaborate. Learning is easier to flip as class preparation tasks can be performed in multiple means (Bergman, J., and Sams, A., 2012) and the teacher is often able to take more of a back seat role in the classroom, allowing more focus on the learners.

Challenges that instructors face when employing the proposed technologies in the classrooms begins with the fact that such methodology is a relatively new for both the students and the teachers. Such challenges include course redesign, teaching load, student acceptance, and student evaluation (Fisher, D., & Waller, L., 2013). Technical issues can sometimes interfere with the smooth running of any class; projectors not functioning properly, Wi-Fi failing, power outage and more. The overloading of servers is obviously a much higher risk when there is more demand as in laptop saturated environments. In some instances this can cause the network to freeze and immobilize the class (Hu, W., 2007). Computers intrinsic issues can add more problems such as software licensing and system crashes (Kraushaar, J.M., & Novak, D.C. 2010). For engineering education, some of the classes are using the engineering Computer Aided Design (CAD) software such as SolidWorks, AutoCAD and others. Such software may be heavy on the computers' memory which requires high-priced computers with high capacities. W-Fi connection was a problem in the early stages of this study, but quickly resolved by our IT department. These and other issues derived from our experience form the focus of the current paper.

Methodology

Endorsing this work, a pilot study with multiple instructors committed to implementing technology in introduction to engineering and engineering design classrooms. The teachers agreed that the ability to give on-task feedback was greatly enhanced by the use of the smart device to give comments on individual and teamwork. Real time discussion usually take place and students save comments for later perusal. This work was carried out by implementing three major modules that make up the proposed solution. The first module involves unified and highly capable laptops powerful enough to overcome any issue that may rise when using devices that are not alike. The distribution of the laptops was carried out in a systematic manner that guarantees that every student was supplied with similar equipment and software package. IT personnel as well class instructors were involved in ensuring the systems' functionality and proper setups for all the students. The equipment included a tablet that runs the latest Microsoft Window as the operating system with touch screen capabilities permitting handwrite annotations and hand sketching. An interactive smart pen was also provided equipped with two buttons mouse as well as a sketching stylus. Additionally, the tablets allowed folding to be held as a clipboard and were equipped with dual cameras for easy scanning, communication and sharing.

The second module contains the needed software that enhance and facilitate the fundamentals of engineering education. The system is equipped with multiple software packages needed to assist the students to learn engineering basics and communicate in team based environments. Naturally, Microsoft office was useful for editing, scheduling and presenting. Since the fundamentals of engineering courses are based on projects, Microsoft project is an adequate tool that facilitates the managing student's projects helping the student with scoping, delegating and scheduling tasks. OneNote is an additional useful software provided in the system which allows for marking, grading and annotating various types of documents for team communication and instructor's feedback. As the name implies, Computer Aided Design (CAD) is employing the computer capabilities to assist the student in finding the correct solution to given problem (Design). The engineering design courses recommends SolidWorks as a CAD tool that provides sketching tools to help the students with 2D representations of found solutions then transform it into a solid (3D) part. SolidWorks also provides modulating methodology allowing the students to mate multiple parts into a working assemblies that can illustrate movement within the mating constraints. Additional software were implemented to enhance the design's modeling and presenting skills for the students as communicators and as team players.

The third module that the proposed study depends on is the classroom environment which is integrated with the latest technologies in teaching and sharing. This works employs a state of art classroom environment named Active Learning Programs or ALPS classrooms. Feedback shows that the services that ALPs brings to the classroom are highly appreciated by the instructors and by the students. Furnished with round tables, the ALPs provide suitable setup for teamwork, yet, these tables are partitioned allowing for row setup for test taking or other individual assessments. One of the contemporary methods suggested for teaching engineering is the cooperative learning where students take lead and teach each other's. Cooperative learning is made easier with all around writable walls provided in the ALPs rooms; with that in place, the classroom turns into an exhibition where students defend their ideas using posters or whiteboards. Another advantage depicted is the availability of multiple power outlets in the

ALPs rooms to supply the students’ devices as well as the instructor’s. Each ALPs classrooms is equipped with five interactive and high definition projectors that allow marking on the screen for annotations and teachers’ notes. Many argue that notetaking is important for the learning process, however, when it comes to engineering methodologies, students’ attention is more important, hence, in the ALPs, all notes are electronic to be preserved and shared. Notes and marking are facilitated with an electronic pen equipped with mouse buttons allowing the notes to be saved as pdf files to be distributed among the students. The interactive projectors also provide hand touch control that, not only manage the screen, but also controls the computer in the same manner of a touch screen tablet.

Research is a needed skill for engineering students and having the World Wide Web in the classroom increases the student’s performance mainly when monitored by the instructors. It was depicted that Engineering students benefited more from the availability of the internet during the conceptual design stages to find proper techniques, tools, parts and industrial terminologies. Sharing with the availability of laptops is significantly altered equipping the students with multiple means to share their work with different illustrative materials. Furthermore, periodic project review meetings, a commonly used methodology needed in engineering design, is monitored, shared and directly commented on with electronic document provided by the teams. The instructors are also given a choice to give back to the students using different tools helping the students understand the point faster and more effectively.

SUMMARY OF SURVEY RESULTS FROM STUDENTS

Surveys were taken periodically during the pilot study to observe the students collaboration and comfort with the injected technologies. The project audience consisted of sixty (60) students with response are of 58%. 63% of the students were females and the rest, 37% were males. The survey consisted of multiple inquiries seeking the students’ insights and ideas regarding the new methodology. The following figures show the responses of the students to weather using laptops in the classrooms helped or hindered their classroom experience.

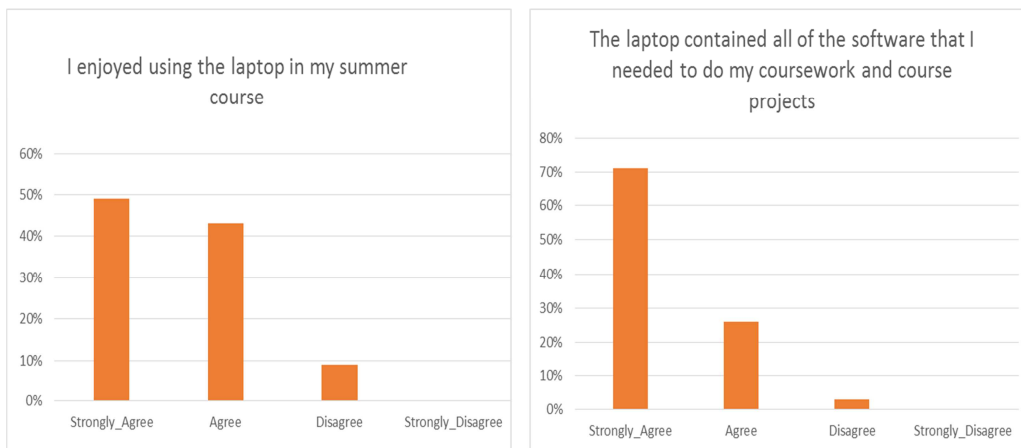
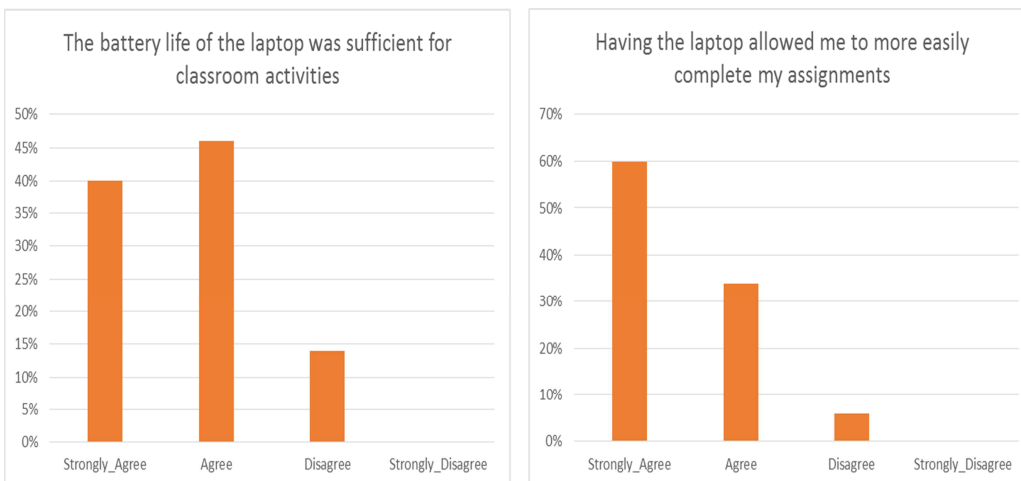
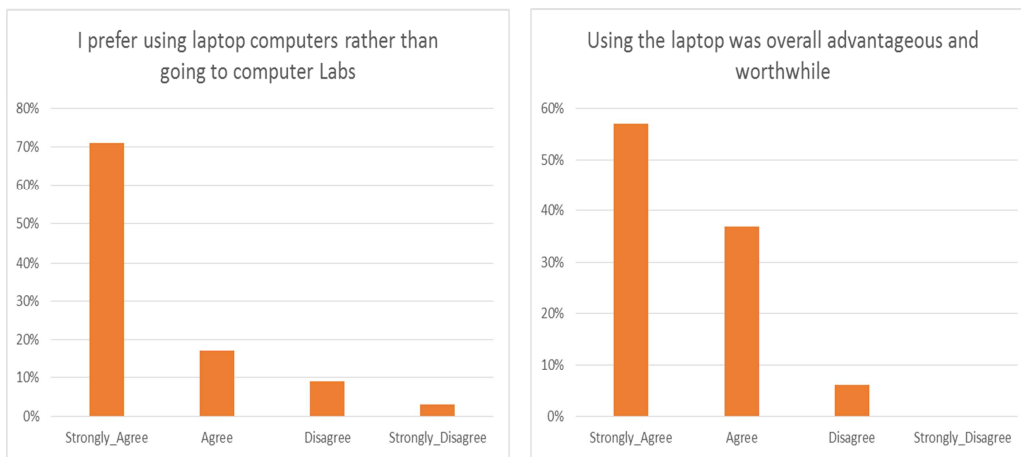
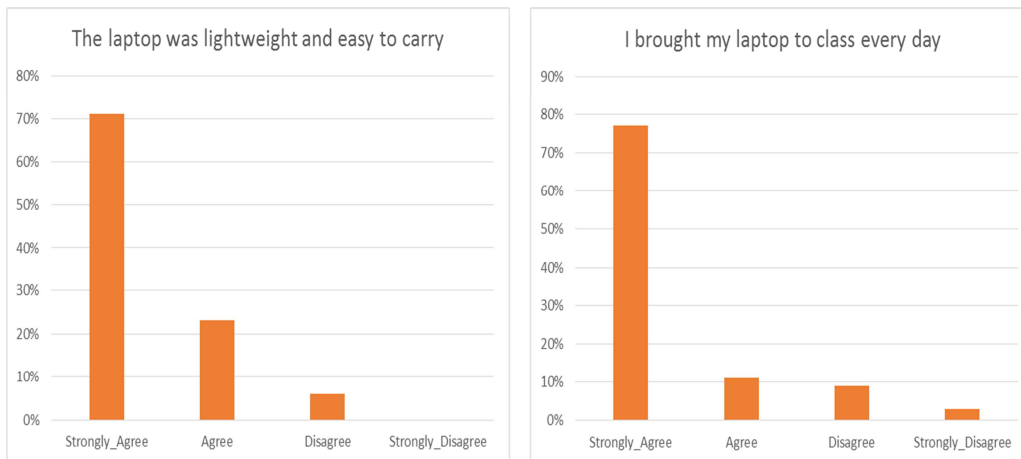


Figure 1: Students to the first and second questions of the survey



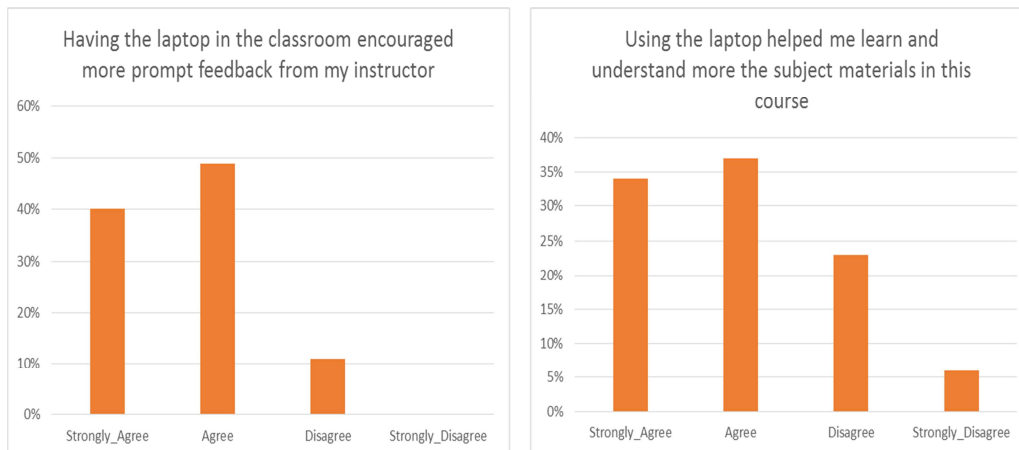


Figure 5: Students to the ninth and tenth questions of the survey

Observed from the results that the overall attitude of the students seem to concur with the implementations of smart devices in the classrooms, additionally, the students were committed to keeping their devices charged and ready for the class. Seeking to obtain more feedback from the students, four open-ended questions were implemented as follows:

Table 1: Open-ended questions for the technology in classroom survey

Question	Common responses of Female students:	Common responses of Male students:
Q1. What was your favourite laptop activity this summer?	<ul style="list-style-type: none"> - CAD, SolidWorks 3D modelling - Taking notes and drawing with the electronic pen - Availability of portable software and PC, ability to work anywhere, anytime - Sharing work with team members using the internet (Drobox, OneDrive, WeTransfer, Facebook, etc.) 	<ul style="list-style-type: none"> - Accessing the internet and University network drives via a Wi-Fi connection (while on campus) - CAD, SolidWorks 3D modelling - Creating (Excel) spreadsheets - Sending Emails - Activities in class that tested listening and emotional intelligence
Q2. What are the major advantages of having laptops available for students?	<ul style="list-style-type: none"> - Common responses of Female students: - Saves trips to the University computer labs - Allows instant corrections and submissions - Allows work to be finished faster, no need to wait for an available computer in labs especially when all of them are being used by others. - Ability to finish tasks and assignments at home - Ability to work during class, with other team members present - Wi-Fi internet connectivity almost anywhere on campus 	<ul style="list-style-type: none"> - Common responses of Male students: - Able to work with other team members much more than before - Access to the University network drives using Wi-Fi (course files) - Assignments can be completed even in class - Access to the internet for research - Getting feedback from the instructor directly in class, rather than via Emails - Easier and faster access to subject materials

<p>Q3. What did you like most about using the laptop as part of your summer course?</p>	<ul style="list-style-type: none"> - Able to work anywhere regardless of location - Able to use Wi-Fi and share files with others easily, wireless connection was fast enough - Able to use CAD (SolidWorks) software at home - Instructor would suggest improvements / changes while I edit the document live. - We have all the course materials with us in the class (available on the internet) 	<ul style="list-style-type: none"> - Tasks could be completed in class - Easy to carry, and always having my work near me - More freedom to work when and where I like - Helps me concentrate more and be more organized (better than using books and many notepads) - Able to access University network drives
<p>Q4. What suggestions do you have for improving the use of laptops in PI courses?</p>	<ul style="list-style-type: none"> - Fix the SolidWorks crashing problem (because it kept freezing up almost every 5 minutes, probably because of not enough RAM). - Install more programs like Photoshop - Change the laptop to one with more power and more memory - Need more laptop activities - Allow students to use their own laptops (the HP laptops often freeze and sometimes we lost our work) 	<ul style="list-style-type: none"> - Use the laptop for other courses like Math, Chemistry, etc. - Include 'iMovie' or 'Movie Maker' - any program that can create or edit videos if possible - Problems with connecting to University network drives need to be fixed. I also want to connect to the University network drives even while outside the campus. - Improve the trackpad design - Allow printing from the laptop

Part of the pilot study, each instructor involved was invited to respond to weekly surveys giving comments on different aspects of the project. Instructors' feedback show that the distribution of laptops and initial technical assistance was made easy with the way IT planned and handled the process with a particular comment on the speed of service. Also, the facilitation of instruction and learning was influenced to varying degrees. It was interesting for them to notice that the students were not particularly impressed, stating that they were happy with their existing laptops and it was not very innovative for them which clearly shows that the students had already been using laptops for educational purposes and were surprised that it took a long time to integrate them into teaching. However, the instructors observed a noticeable difference in the following weeks, for example, in the second week the students realized the usefulness of laptops as an instructional tool when they were asked to carry out certain tasks following particular instructions. Some other instructors observed that students brought their laptops along when they visited the instructors during their office hours. Also, one of the instructors stated that the initiative gave the students motivation to Blackboard application more frequently to retrieve course documents. One instructor perceived the improvement of the teamwork and projects based tasks during class which allows feedback to be given and incorporated in the projects immediately. Similarly, another instructor pointed out that feedback sessions were facilitated greatly mainly because all the students had access to the correct files, charts, sketches etc. when the teacher felt the need to give instant feedback on student outputs. The instructors felt that the project reviews were also affected by this positively when both students and instructors were able to share their work, comments and review of their tables, charts etc.

CONCLUSION

Technology in classrooms is argued to push the students to work in an efficient manner that guarantees to cover all the basis of the learning aspects including teamwork, projects, research, communication and more. Engineering education, in particular, shows to be highly affected by the injection of technology in the classroom due to the dependence of engineering on technology. In this study, a closer look on the students and the instructors' attitude toward technology imparted in the engineering education classrooms as an immediate interaction tool. Results shows that, in the beginning, students seem to show a little resistance to the concept of carrying laptops to class and

learning new computer tools, however, they showed positive attitude as the class preceded to be structured to satisfy their needs for technology aiming to achieve robust and comprehensive engineering outcomes.

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