Project-X: An Initiative to Increase Student Engagement through Laptops

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Abstract

Today's digital natives enthuse educators to consider the impact of technology on learning and plan proper instruction, involving the use of laptop along with other technologies. However, implementing laptop use in classrooms without adequate support from administration, IT and faculty can have limited benefits. This article presents the results of a project conducted to identify the perceptions of students and faculty about ways in which the laptop use affects the learning environment at the Petroleum Institute, Abu Dhabi for two courses: Strategies for Team Based Engineering Problem Solving and Communication. Sixty-four freshman students, six instructors and two IT members were involved in the project. Quantitative and qualitative data were collected from students and faculty using a student survey, weekly electronic faculty-feedback logs, and electronic student journals. Data revealed that the use of laptops in the classrooms enhanced the feedback process on team-assignments in particular. Instructors felt that integration of laptops facilitated syllabus delivery and classroom management. Results also indicated challenges related to technical issues such as battery-life and Wi-Fi interference. It was further found that initial student and faculty training is essential for the project to have greater success. Results are discussed and recommendations are made for effective integration of the laptop in active learning environments.

***Keywords**: Laptop; Active learning; Student engagement; Team learning; Engineering education*

Introduction

The pace at which technology develops is phenomenal, with technological innovation being an almost daily occurrence. These developments are normally welcomed thanks to their effects on "enhanc[ing] human capabilities in terms of what humans can do now compared to what they did a few decades ago" (Kumar, 2013, p. 1). The effects of new technologies are particularly evident in education. The range of technologies in educational settings today offers opportunities for differentiated and more inclusive learning. One such technological tool is the laptop, whose portability seems to be a key reason for its popularity. Students' engagement in interactive learning experiences offered by a laptop can make learning more meaningful and enjoyable, allowing them to assume responsibility for their own and peers' learning and leading them to be active agents in the learning process. Such benefits have influenced many tertiary educational institutions to exploit this technology more.

Shneiderman notes that "The old computing was about what computers could do; the new computing is about what users can do. Successful technologies [therefore] are those that are in harmony with users' needs" (2003, p. 2). This sentiment is reflected in the early developments of portable computers hoped to give the users more freedom to use computer technology on the go. Several attempts were made to make this possible with the production of the Xerox Dynabook, the Osborne 1, Compaq 1-3, Compaq SLT, and Subnotebook (Gookin, 2010). With the introduction of the personal computers in the late 20th century, diverse user needs were given considerable consideration, resulting in a variety of applications such as graphical user interfaces and information visualization (Shneiderman, 2003). These have impacted the laptop technology in such a way that user needs are now addressed more effectively. It is important to note how individuals' learning and education are impacted by this development.

Benefits of Laptops in Learning

Incorporation of laptops in student learning is becoming an increasingly significant practice with varying claims being made as to how the employment of such technology affects teaching and learning, as well as questions relating to ease of use. One benefit of students using laptop in classes is that it helps them become skillful users of computer technology including processing programs such as Microsoft Works, Open Office, and sound and video editing software (Witting, 2011). These tools provide the fundamental ICT skills required for success in and beyond higher education.

Another is related to autonomous learning. The laptop can be a very convenient tool enabling students to be more self-reliant in terms of such skills as web searching and sourcing. For example, students can be guided to reliable data bases, search for relevant sources and receive teacher feedback. Those who still struggle with Boolean Operators can be given specific 'over the shoulder' guidance from the instructor and apply this immediately and independently. As noted by Efaw, Hampton, Martinez and Smith (2004), the need to leave the classroom to visit the library is removed and thus there is no distancing between the immediate research need generated in the classroom and the library 'follow up'. There is empirical data showing that students utilizing laptops in their studies increase their confidence in expressing their ideas, develop their communication skills, and therefore become more independent learners (Tubaishat & Bataineh, 2009).

Real-time feedback provided to students is another benefit. Feedback given to students in the traditional way of paper and pen often has a delayed mode. Electronic feedback, however, can be more spontaneous and instant. The instructor's ability to give on-task feedback can be greatly enhanced by the use of the electronic stylus to make comments on student assignments. Saving comments for later perusal, students can benefit from real- time discussion with their instructors and peers during the class-hour. This also helps prevent the instructor's feedback, notes and comments on the board from being "erased at the end of the class" (Efaw et al., 2004).

Furthermore, the accompanying technology (wireless network, drop box, multiple-projection) allows students' work to be directly projected and commented on for the whole class to see and respond to at any time. Empirical evidence indicates that students' use of laptops in large classes in particular enables meaningful interactions among students and between students and the

instructor, further promoting active engagement in the learning process (Barak, Lipson & Lerman, 2006). Resulting discussion is an observably useful learning experience for all.

The laptop also causes a shift in the teacher's role from 'the holder of all knowledge' to 'the facilitator of the learning process', allowing students to be active agents in the learning process. Classroom roles are easier to flip as class preparation tasks can be multi-mode (video, audio, text) (Bergman & Sams, 2012), and the teacher is often able to take more of a back-seat role, allowing more focus on the learners. This enables the teacher to refrain from teacher-centered instruction. Learning assignments and tasks carried out using the laptop have the potential to engage students in cooperative and project-based learning (Belanger, 2002) which creates active learners. Mouza and Cavalier (2013) found that students using laptops organize their study-notes more effectively, access more information and resources available on the Internet, and increase the efficiency of their work, with an overall positive effect on their academic success. They also note that laptops allow students to pursue their own learning interests. This likely attracts students to learning in and outside of class. In fact, student classroom behavior and attendance rates have been reported to improve in classes where laptops are used for education (Bolick & Cooper, 2011). Collectively, these increase students' motivation for learning (Mouza & Cavalier, 2013) and results in greater levels of satisfaction with the tool (McVay, Snyder & Graetz, 2015).

Readiness for learning is another advantage of using laptop for educational purposes. It is not uncommon to hear teachers complaining that students do not have the requisite course documents ready for class. Using laptops means that course and student documentation is always at hand given the multiple digital modes for archiving and storing documents and data.

By using the laptop, the teacher can also address a variety of learning styles. Leask and Pachler (2005) indicate that different kinds of media help "students to capture their thoughts and to demonstrate their understanding in a number of ways" (p. 83). For example, students who have difficulty in expressing themselves using text may opt for audio-visual or graphic media. They further note that it is easier for students to take their laptops outside class to collect data using a variety of data-logging peripherals or webcams. Naturally, this allows students to use a variety of learning styles and provides them with active learning opportunities.

Taken together, the aforementioned advantages of the laptop use in educational settings contribute to students' development of lifelong learning skills essential for meaningful and autonomous learning. This is achieved by addressing the need for 'digital competence', the fourth of eight lifelong learning key competences identified by the European Commission (2007). This competence is defined as "the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet" (p. 7). It is also emphasized that learners develop their critical thinking, creativity, and innovation skills by using IST. There is no doubt that students' engagement in purposefully designed and effectively managed learning environments involving laptop use will develop their digital competence, and therefore enhance their overall lifelong learning skills.

Challenges

Despite the benefits of the laptop for educational purposes, there are challenges that educators and students alike need to be aware of. The research indicates that these tend to be of the following types. First, technical issues can sometimes interfere with the smooth running of any class; projectors not functioning properly, Wi-Fi failing, power outage and so on are all familiar inconveniences. The overloading of servers is obviously a higher risk when there is more demand, as in lap-top heavy environments. In some instances this can cause the network to freeze and immobilize the class (Hu, 2007). Computers crashing as a result of sizeable software packages is another problem. This is common with engineering drawing software such as Solidworks and AutoCAD where the choice of laptop and specs in general is crucial (Autodesk, 2015).

Other questions relate to the range of non-technical interference which in-class Wi-Fi connectivity can bring. In a 2011 study at Stanford University, three quarters of the surveyed students indicated they spent 'more than ten minutes per class using social networking sites and email' and 46% of respondents not directly involved in such activity, showing that it was distracting to them (Zhu, Kaplan, Dershimer & Bergom, 2011). Bhave (2002) also notes that the vertical nature of the laptop screen can be more distracting than notebook devices. Fried points to similar findings, in which "too many sources of information can create cognitive overload, and new information coming in can cause attentional shifts and distraction" (2008, p. 908).

Also, Wi-Fi connected laptops can be very 'busy' with a lot of visual interference from messaging, advertising and other pop ups, lighting changes, meeting and appointment alarms and other traffic which may also affect student attention. All of this can have an impact on students' ability to concentrate and adequately process target information (Chun & Wolfe, 2001).

These studies were carried out in unstructured courses with large student numbers which often took place in lecture halls (Barak et al., 2006). Perhaps unsurprisingly, in structured courses with smaller student populations, the same results appear not to be found (Kay & Lauricella, 2011a). This also raises the question of to what degree the technology is purposefully and seamlessly integrated into the learning/ teaching dynamic and effectively connected to the curriculum (Sung, Chang, & Liu, 2016).

There has been less attention paid to instructors as users and practitioners. Preparedness with respect to attitude, knowledge, and confidence in use and requisite skills is obviously an issue in teachers' willingness and readiness to integrate this technology into their teaching (Ward & Parr, 2010). Much of the research has focused on benefits for students and learning, and the jury still seems very much 'out' on this question (Lederman 2016). Further, these factors also influence an instructor's ability "to plan and implement effective lessons with technology to support curriculum learning" (Parr & Ward, 2011, p. 55). Professional development is therefore an issue given that teachers not only require technical skills but also "the pedagogical or curricular content necessary for integration" (op cit).

Our Teaching Context

Founded in Abu Dhabi in 2001, the Petroleum Institute is an engineering university offering undergraduate degrees in Chemical Engineering, Electrical Engineering, Mechanical Engineering, Petroleum Engineering and Petroleum Geo-science. Since its inception, students have had access to computing resources in labs. Five computer labs are configured with office automation and general engineering software and are maintained by the IT department. These so-called "open labs" are heavily used by undergraduate students for homework and research. For male students, the IT open-labs operate from 7:30 A.M. until late night at 11:30 P.M. Male students generally have no issues accessing the labs and doing their homework, assignments, or project work. However, software licenses are obtained from a campus network server, so access is restricted to students on the university grounds. Access to open-labs for female students is more restrictive as the female campus closes by 5:30 P.M. This inaccessibility of IT resources puts all students in a difficult position during project deadlines and prior to examinations. Consequently, the IT department launched a strategic initiative called Project X to make computing equipment available to all students with the general aim of reducing the above-mentioned problems and furthering innovative teaching and learning opportunities. In this sense, Project X was a strategic goal for PI in 2015 and a key initiative with the following goals: a) improve IT services and give anytime/anywhere availability and accessibility to IT resources for PI undergraduate students, b) reduce the risk of unavailability of IT services for students since the laptop comes pre-installed with key applications such as MS Office, TrendMicro, Matlab and Solidworks with standalone licenses, and c) add strategic value to PI to establish itself as a world class teaching and research institution by improving the process of teaching and learning. (See Figure 1 for a summary of these goals).

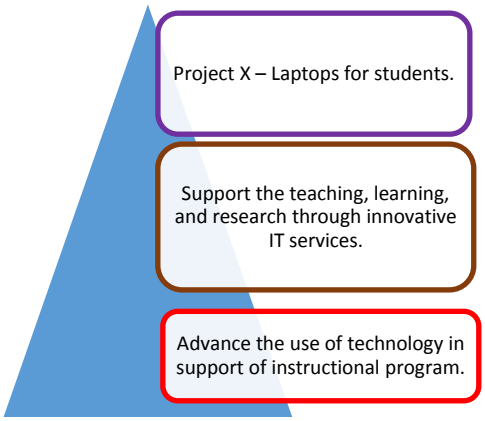

Figure 1. PI Technology Goals

Integration of Laptop into Teaching at PI

Having access to laptops alone however, is not enough to have the desired impacts. Support from administration, IT staff and individual departments is also necessary for helping learning environments and teaching methods to be laptop-friendly (McVay et al. 2015, Sung et al., 2016). To

this end, a group of faculty and IT specialists at PI set up a project to identify ways in which the laptop technology impacts learning in two learning environments. One class was Strategies for Team Based Engineering Problem Solving (STEPS). In STEPS classes, students work in teams to apply scientific knowledge and communication competencies to find engineering solutions using a systematic design process. Taught by engineering and communication teachers as co-instructors, STEPS provide active participation environments where the instructors play roles as clients and/or consultants allowing the students to take initiatives and the lead in implementing the project. Similar to the STEPS classes, the Communication course aims to provide students with a variety of skills they require as successful engineers such as research, report writing and oral presentations. The course engages students in a term-based project-based learning environment where students work both individually and in teams to conduct primary research. As in the STEP classes, the instructor assumes the role of a facilitator encouraging students to take responsibility for their own as well as their peers' learning. The instructors in both courses agreed to use of the smart device to give on-task feedback on individual and teamwork assignments. Real time discussion usually took place among the members and with the students to track progress and provide recommendations for further perusal. This work was carried out by implementing three major subsystems, which are explained in detail below.

Hardware Implementation

The first subsystem involves uniformed and high-end laptops which were initially thought to be enough to overcome any issue that may rise when using some of the software. Every student was issued with the same computer and software packages. IT personnel as well teaching faculty were involved in ensuring the systems' functionality and proper setups for all 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-stylus was also provided. Additionally, the tablets allowed folding to be held as a clipboard and were equipped with dual cameras for easy scanning, communication and sharing.

Software Implementation

The second subsystem contains the required software that enhances and facilitates understanding of the fundamentals of engineering education. The system is equipped with multiple software packages assisting the students in learning 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 facilitates managing student's projects, helping the student with scoping, delegating and scheduling tasks. OneNote is useful software provided in the system which allows for marking, grading and annotating various types of documents for team communication and instructor's feedback. Computer Aided Design (CAD) employs the computer capabilities to assist the student in finding the correct solution to a given problem (Design). The engineering design courses recommend SolidWorks as a CAD tool providing sketching tools to help the students with 2D representations of solutions and transforming it into a solid (3D) representation. SolidWorks also provides modulating methodology allowing the students to mate multiple parts into 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 laptop provided the students the chance to perform a range of in-class activities such as freehand sketching or pencil drawing exercises, preparation of three different PowerPoint presentations on engineering design, and several 'assembly drawings' and 'detail drawings' of the 'major project'.

Classroom Environment

The third subsystem is a state of art classroom environment named Active Learning Programs (ALPs). Equipped with interchangeable tables, the ALPs provide a suitable setup for teamwork or individual activity and the kind of cooperative learning modes appropriate for engineering students. All-round writable walls allow students to perform presentations using a variety of media such as posters or whiteboards as well as work on documentation. As shown in Figure 3, each ALPs classroom is equipped with five interactive and high definition projectors which can be uniquely allocated to each team. This facilities activities such as screen-written annotations, teachers' notes and real-time review of documentation as well as cross-team sharing.

Figure 2. An ALPs Classroom

Research is a critical skill for engineering students, and having in the classroom access to the WWW can increase student engagement. Engineering students benefit from the availability of the internet during the conceptual design stages to find proper techniques, tools, parts and industrial terminologies. The availability of laptops has offered the students 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 feed-back to the students using different tools helping the students understand the point faster and more effectively. There is thus a practical, real time need for the use of the laptop and a clear integration with the curriculum.

Research Questions

Considering the role of laptop use for educational purposes in general and in our teaching context in particular, we aimed to answer the following research questions.

1. What are the student perceptions of the Project-X Laptop initiative in terms of its effects on their learning?

2. What are the faculty perceptions of the Project-X Laptop initiative in terms of its effects on teaching and learning?

Method

Participants

This project involved 64 students. 30 (43%) were freshmen enrolled in the Communication course, while 34 (57%) were sophomore students in the STEPS course. The students were 29 (42%) male and 35 (58%) female. Of the 64 students participating in this project, 35 completed the online survey giving a response rate of 58%. Of these students, 63% were females and 37% were males. The project also involved four STEPS instructors, two Communication instructors, and two members of the IT support team.

Data Collection Tools and Analyses

Both quantitative and qualitative data were collected using a variety of instruments. One of these was a student survey. The quantitative data from the students were generated through the use of Likert-type questions which required them to indicate the extent to which they agreed with the given statements. Some statements included “Having the laptop allowed me to more easily complete my assignments.”, and “Having the laptop in the classroom encouraged more prompt feedback from instructor.” Qualitative data were collected using open-ended questions asking the students to explain their feelings and attitudes about the use of laptop technology in and outside of the classroom for educational purposes. Qualitative data were also collected from the students through an electronic journal. Students were asked to reflect on their experience of using the laptop in the classroom i.e. benefits, challenges, suggestions. The journal entries needed to be at least one paragraph long. They were asked to provide examples on any of the issues raised through their reflections.

Qualitative data from the instructors were collected using a weekly feedback log with open-ended questions requiring them to comment on the technical aspects of the laptops, and how they felt the use of laptops affected students’ learning and their own teaching. Sample questions included, “What activities involved the use of laptop in your teaching?”, “What did and did not work? Why?”, and “How would you rate student participation?” In addition to the weekly feedback log, regular

meetings were held to discuss the project in greater detail. The minutes taken during these meetings also generated some qualitative data for this research.

The student survey was administered electronically. To supplement the data from the interviews, anecdotal data were collected through informal dialogues with some students and instructors, in addition to the reflective student journal. The student response rate was 58% while all six faculty members responded to the questions in the electronic log. The number of students (35) who provided data for the study is relatively low. However, considering the total number of students involved in the project (64), the 58% response rate may still be considered significant. We acknowledge that the small number of survey respondents in this study limits the generalizability of the results, not only to wider contexts but to the immediate context in which this study was conducted. However, the qualitative data supported the limited quantitative data, increasing the validity of data interpretation. This is consistent with the observation that qualitative studies may study significantly "fewer people, but delve more deeply into those individuals [and] settings, hoping to generate a subjective understanding of how and why people perceive, reflect, role-take, interpret and interact" (Baker & Edwards, 2012, p. 8). This was the case in the current study, and we felt this would provide valuable insight into learning of students who generally constitute quite a homogenous group of learners at the institute.

Similarly, with the data collected from the instructors, while six is a small number, the study involved all freshman instructors teaching during the summer course when this project was undertaken. Five of these instructors are the authors of this current paper, who were 'actors' in the teaching and learning situation investigated. In this sense, this research benefits from a partly phenomenological approach whose purpose is to "illuminate the specific, to identify phenomena through how they are perceived by the actors in a situation" (Lester, 1999, p. 1). Also important to note is that all instructors provided regular weekly feedback through the purposefully developed electronic log, weekly meetings and informal exchanges generating ample data from which careful interpretation was made. Lester (1999) also notes that "in multiple participant research, the strength of inference which can be made increases rapidly once factors start to recur with more than one participant"; however, although "phenomenological research can be robust in indicating the presence of factors and their effects…, [it] must be tentative in suggesting their extent in relation to the population from which the participants or cases were drawn" (p. 1). Therefore, we believe that the data-collection methods used in this study collectively provided us with relatively rich data from which careful interpretations could be made.

Quantitative data collected were analyzed using descriptive statistics such as frequencies, while the qualitative data were organized around emerging themes.

Results

Results from Student Feedback

The first research question elicited students' opinions on the effects of the Project-X Laptop initiative on their learning. They were asked questions relating to their experience using this laptop

computer (1 laptop per student). The first category of questions was related to technical aspects, a summary of which is provided in Table 1.

Table 1. Students' Satisfaction Levels of Technical Aspects

Statements	Agreement scale (N=35)			
	Strongly agree	Agree	Disagree	Strongly disagree
The laptop contained all of the software that I needed to do my coursework and course projects.	25	9	1	0
The laptop was lightweight and easy to carry.	25	8	2	0
The battery life of the laptop was sufficient for classroom activities.	14	16	5	0

Table 1 shows that almost all of the students (34) were satisfied with the software that came with the laptop, allowing them to complete their coursework as required. Likewise is the case with the ease of carrying the laptop. 33 of the students were happy with their laptops' lightweight. However, comparatively less students (30) seemed discontent with the battery life, causing some frustration to some students (5).

A second set of questions focused on attitudes to overall use and satisfaction with their laptops. Table 2 summarizes the data.

Table 2. General Use and Satisfaction with Laptops

Statements	Agreement scale (N=35)			
	Strongly agree	Agree	Disagree	Strongly disagree
I brought my laptop to class every day.	27	4	3	1
I prefer using laptop computers rather than going to computer labs.	25	6	3	1
Using the laptop was overall advantageous and worthwhile.	20	13	2	0
I enjoyed using the laptop in my summer course.	17	15	3	0

A significant majority of the students (31) brought their laptops to class everyday as required. The other students seemed to depend on their team-mates. The same percentage of students enjoyed being able to use their laptops in the classroom or in their own learning environments without having to go to the computer labs. 33 of the students thought integration of the laptop was beneficial, and they were satisfied being in a laptop-enhanced learning environment.

Respondents were also asked to state the extent to which they agreed with certain statements on advantages of the laptops.

Table 3. Students' Opinions on Advantages of Laptops

Statements	Agreement scale (N=35)			
	Strongly agree	Agree	Disagree	Strongly disagree
Having the laptop allowed me to more easily complete my assignments.	21	12	2	0
Having the laptop in the classroom encouraged more prompt feedback from my instructor.	14	17	4	0
Using the laptop helped me learn and understand more of the subject materials in this course.	12	13	8	2

As shown, 33 of the students thought their laptops facilitated the process of completing their assignments. Similarly, 31 thought that instructor feedback was made more prompt thanks to the laptop use. These, however, were in contrast with the percentage of students that believed their laptop helped learn more of the subject materials in their courses (25). Almost one third of the students (10) did not agree with the given statement.

The open-ended questions in the survey together with anecdotal data collected through conversations with students supported the quantitative data reported above. When they were asked to comment on the specific benefits of the laptop project on their learning, several themes emerged. First, it was frequently remarked that the project made positive differences in the ways that they worked individually and in teams. One of the factors that contributed to this was the convenience of accessing essential software tools at any time of the day, at almost any location. One student stated "We don't need to wait for an available computer in labs, especially when all of them are being used by others." Similar remarks were made by others: "No more need to visit computer labs on campus!", and "The software we need is available all the time, unlike computer lab PCs which must be shared with other students." Another student noted "[We] are now encouraged to work [more], due to 24/7 software availability. No excuse 'I don't have the necessary software' is accepted anymore." A similar comment was made in a student's journal entry: "This course was a delightful course that motivated me to do much work in a short period of time by using the laptop. Moreover, the most feature I liked about the laptop was providing the PI's desktop into our laptops. That helped me a lot since I can complete my assignments even if I was outside the PI campus."

Another theme emerging from analysis of the qualitative data was related to students' ability to access the internet and share work with other team members almost anywhere, and anytime. One student supported this by saying, "Using the internet, [thanks to] to the WiFi connection, made our team research work much easier." Another stated that, "While on campus, I could access the Internet and university network drives via a WiFi connection." The same student stated that the Internet access made it easier for her team to keep team-related documents in an online folder. The use of online environment such as DropBox, OneDrive, We Transfer, and Facebook for this purpose facilitated the research writing process the students were engaged in most of time during their Communication course in particular. Another student said, "We have all the course materials with us in the class available on the Internet, so always ready for class". This is clearly important in class preparation. Access to the Internet, not only in the classroom but also anywhere on campus, was

another reason for the students' tendency to share materials with their team-members. In a conversation between the students and one of the researchers, a student commented, "It is good to have my laptop with me all the time. Even if I can't come to class, I can send my share of work to my team members easily."

A third theme was ease of improving work. This mainly stemmed from the students' ability to make immediate changes to individual assignments and project work. A common comment was related to instructors' instant feedback, which increased the speed at which corrections could be made by the students. In the words of one student, "Preparing and updating documents with immediate feedback from the supervisor increases the pace and quality of the work." Similar comments were made by other students: "Assignment now can be completed even in class ☺", "Instructor … suggest improvements [and] changes while I edit the document live", "[I am] able to start assignments earlier", and "[The laptop] saves a lot of time, a lot work can be done in a short time."

Technical aspects were also commented on. The students particularly enjoyed using the electronic stylus, the touch screen, and the revolving screen. Collectively, these gave them a feeling of interactivity with technology. One student, "I feel in more control when I use the electronic stylus on the touch screen." Some other students mentioned that the revolving screen made it easier for the team members to show their work to each other without having to leave their seats. This, they believed, saved them time and energy.

The aforementioned advantages of the laptop technology for educational purposes were a corollary to the theme of motivation mentioned by many students. The variety of applications made available to students created greater intrinsic motivation for learning. The students in one particular Communication class mentioned their experience of creating and editing videos using online applications such as Glogster gave them the opportunity to use their imagination. This helped them become more creative, which "added flavor to some less exciting aspects of the course" in the word of a student. On the other hand, SolidWorks (CAD software) used in the other class (Strategies for Team Based Engineering Problem Solving) helped students understand content matter better, increasing their motivation for learning. One student compared his experience of using books and notepads to the laptop, and said "I like my classes more now because the laptop helps me concentrate more and be more organized." Similarly, in a journal entry a student made the following remark: "This was my forth week using this laptop. I used it this week to annotate my articles for individual writing 2. In addition, I used it to present our progress report. This week also we asked to transfer our results into graphs using excel Microsoft Office. I faced no challenges this week, everything was going smoothly." Taken together, these remarks by the students provide evidence that the laptop project increased motivation and engagement in learning. They were also aware of the value of a technology- infused curriculum and how their roles have changed from recipients of knowledge to active learners who were in charge of their own learning.

The qualitative data from students also supported the quantitative data on some of the limitations of the laptop use. These mainly concerned SolidWorks, which often crashed due to the graphics hardware or software problems. The students often felt frustrated. They felt it caused them to lose useful class time. Another drawback was related to the limited range of software pre-installed on the laptop. The students expressed their interest in full subscriptions to online applications such as PowToon. They also indicated not being allowed to install their own software was restraining since

they wanted to experiment with a wider range of applications in support for their learning. Some indicated that this limited their freedom and creativity.

Faculty Feedback

Our second question related instructors' opinions on the effect of the Project-X Laptop initiative on teaching and learning. In the context the phenomenological aspect of this study, the instructors, as active actors and researchers, participated in intensive data generation. To this end, they were invited to respond with weekly logs giving their opinions and feelings on different aspects of the project. The analysis of their responses revealed the following themes:

Distribution of Laptops and Initial Technical Assistance

Overall, the instructors were happy with the way IT planned and handled the process. They made positive comments about the speed of service in particular.

Facilitation of Instruction and Learning

Teaching appeared to be influenced to varying degrees. One of the questions asked was related to students' perception of receiving laptops. It was interesting for them to notice that the students were not particularly impressed initially, stating that they were happy with their existing laptops and it was not something very innovative for them. One instructor said "They don't see it as something earth-shaking. They feel as it is an existing tool that we finally got around to using in the classroom". Students had already been using laptops for educational purposes and were surprised that it took a long time for PI to integrate them into teaching. Interestingly, some students also stated that it was not necessary to use laptops in class.

In the following weeks, though, the instructors observed a noticeable shift in students' negative perceptions. For example, in the second week the students mentioned the usefulness of laptops as an instructional tool when asked to perform certain tasks following particular instructions. Some other instructors observed that students brought their laptops along when they visited the instructors during their office hours. One of the instructors stated that the initiative gave students impetus to use the Blackboard application more frequently. This instructor noted that she was able to incorporate many elements of a flipped course, which in turn decreased the amount of teacher-fronted classroom instruction.

Some instructors also enjoyed the laptops' contribution to students' interaction with them. That is, they were able to have more conversation regarding course work. One instructor said "The teams seem to work [more] on their projects during class which allows me to give feedback they can incorporate in their projects immediately." Students were therefore motivated to produce more work, and consult their instructors while they were on task. Similarly, another instructor noted that feedback sessions were facilitated greatly because all students had access to the correct files, and sketches when the teacher felt the need to give instant feedback on student outputs. The instructors

felt that project reviews were also affected positively when both students and instructors were able to share their work.

Laptops also helped instructors plan instructional activities requiring students to use hand-sketches/drawing using Windows 7 Paint and an HTML 5 browser application. These were regarded as student friendly. Another instructor had his students use Glogster, an online presentation tool, in their presentations. He remarked that the students were generally more at ease with using PowerPoint compared to Glogster, although they were happy to try out new apps. Additionally, some instructors observed that their students' research skills were enhanced as a result of their engagement in basic research on a variety of topics using internet sources. The instructors were able to provide the students with guidance on differentiating between reliable and unreliable sources. This was facilitated by both parties' instant access to enabling information technologies.

Instructors also observed that students' project management skills were positively affected by their use of the Hierarchy Chart tool in Word to create objective tree diagrams, and MS-Excel to create project schedules/Gantt Charts and enter data for analysis. Having instant access to PI network folders encouraged them to refer to relevant course materials regularly.

Technical Aspects

Faculty made positive remarks about the technical aspects of the laptop and classroom settings. First, certain aspects of the laptops made them quite popular. One of these was simply their light weight and small size, which made quite user-friendly especially when the students and instructors had to carry so many items. Also popular was their convertibility into tablets with rotating screens, thanks to which the students were able to share their work with others. The touch-screen function was also welcomed with a lot of enthusiasm initially. However, its super–sensitivity became a formidable challenge for some people. The electronic stylus that came along with the laptops was another factor increasing the popularity of the laptops. However, both the instructors and the students were in need of some training on how to use this more effectively. STEPS instructors noted that the Window 7 operating system was not effective in detecting different levels of contact pressure from a stylus, felt necessary for natural hand sketching control.

Teachers also suggested that battery life might be disappointing, especially when the students were required to use certain software programs with heavy load. In cases of laptops not fully charged prior to class, the students often moved away from their teams to recharge them. At times, the problem became more serious due to lack of enough power outlets available in some classes. Taken together, these had negative effects on students' time-management.

Another very serious challenge the STEPs instructors faced was related to SolidWorks, which crashed several time during the lessons. More often, this caused STEPs students to resort to the lab Pcs to do their CAD exercises and CAD homework. One of the instructors also made the remark that the screen size was not adequate for SolidWorks CAD usage. They also thought that a three-button mouse would be necessary to use SolidWorks properly.

The instructors also faced challenges in connecting their laptops to the projector. The HDMI cables did not work. The problem increased when the speakers did not work either.
When asked how they felt about the ease of WiFi connection, they remarked that it was easy in general though was assistance needed at the initial stages.

Discussion

This paper focuses on the implementation of an initiative the Petroleum Institute which facilitated active learning in the classroom with the help of laptop technology. The evaluation of the project through student and instructor feedback provided helpful insights. First, all key stakeholders who were involved in the implementation process described positive benefits. Primarily, both students and teachers indicated that feedback was made easier. STEPS courses, for example, are team-based and written documentation is a major focus. Teachers found they were able to engage the students more during the production of documentation and to be more closely involved in the generative process. Feedback was felt to be more relevant, timely and focused and enabled students to make immediate qualitative improvements. This was enhanced by the use of the stylus which allowed real-time changes which the students could respond to at the time and/or save for later. The instructors were able to evaluate students' progress and needs consistently which they felt facilitated and improved the learning process. Writing and revision for example can be directly observed and requisite improvements made. Warschauer also found (2005) that "students were able to revise their work much more readily. An important part of becoming a good writer is learning how to edit and revise one's work in multiple drafts, yet this is naturally hard to teach when papers are written by hand. Students revised their work more easily with laptops…." (p. 6). Since the majority of the students did much of their work in class, they were able to actively engage and learn from regular instructor feedback. (Mouza & Cavalier, 2013).

With respect to teaching, comments by teachers leant more towards how certain elements of syllabus delivery and classroom management were improved, rather than how teaching per se was enhanced. The latter would be a useful focus for further study. For example, the use of particular applications such as Windows 7 Paint were seen by the engineering colleagues (who are teaching engineering design) as making class preparation easier as well as being user friendly. On-line drawing programmes were also easier to access and always available to all students. As Lowther, Ross and Morrison (2001) found, this kind of accessibility can have a positive impact on student research, writing and design. (2001). Hay and Lauricella (2011) also identify the advantages of being able to easily access subject-specific software, a benefit felt to be very significant by the engineering faculty in the current study.

Two common themes mentioned by faculty were the positive impact on in-class student motivation and increased teacher-student interaction especially through real-time feedback. The laptop use in these courses is always clearly task related and on a 'task need' basis. There is never any confusion on behalf of students as to why the technology is being utilized. This is an element of the factor of integration mentioned earlier (Sung et al., 2016). Further, a number of faculty commented on increased engagement and collaboration, doubly important in the context of team-based learning as used in these courses (Murray 2011). This runs contrary to the issue of using technology for technology's sake, noted to create a negative dynamic in the classroom and depriving the learning

environment of potentially meaningful interaction. (Borsheim, Merrrit & Reed, 2010). Access to technology facilitates the ongoing interaction where students work together in teams and instructors lead the classes as facilitators. Murray also notes that this enables each participating student to contribute to the project to the best of their abilities (Murray, 2011). This was certainly our experience.

Teamwork is a central dynamic in the STEPS and Communication courses where students are required to form teams at the beginning of the course and produce most of their work in this context. As stated by one of the faculty, during this project, the teams worked on their projects more during class than in previous semesters and this was felt to allow an increased interaction between instructors and students, particularly with reference to instructor input on developing work. This can further allow a shift in pedagogy to a more collaborative and student-centered focus based on learner need, and as one colleague pointed out "decrease the reliance on teacher-fronted classroom instruction." As Weaver and Nilson (2005) identify, such shifts can lead to, "more student-centered approaches relying on interaction, participation, collaboration, and hands-on experience" (p. 5). This would be fertile ground for further exploration in our environment.

The above-mentioned collaboration allowed the faculty to work with individual teams more closely and further encourage teams to focus on the quality of their work which was now more accessible to be examined more closely by their instructors. As one instructor highlighted, "The teams seem to work [more] on their projects during class which allows me to give feedback they can incorporate into their projects immediately." Previously, to engage in teamwork more fully, faculty needed to put a lot of effort to spark the interest and discuss its benefits. Now, work seemed to be divided fairly as team members interacted frequently through emails and social media apps such as WhatsApp while recognizing and supporting the strengths and weaknesses of their team members.

We are all bombarded by 'apps' and our students (like any others) are interested in trying new ones. Teachers also have an interest in presenting useful educational apps to their classes and one respondent introduced the digital presentation software, Glogster, to his class, enabling them to give more interactive presentations. The simple fact that all of the students had a laptop obviously makes access to such resources more immediate and the teacher is able to guide the student to more relevant tools which they can immediately begin to apply for a real purpose. Similarly, relevant internet sources can be instantly accessed and the required search skills (Boolean, for example) can be developed and applied in real time for a real purpose. This includes student research projects, where the use of the laptop can facilitate significant parts of the process. This increases engagement. As Miller points out; "The laptops make the projects and research my students participate in easier, and they engage more" (2008, p. 174).

The level of team interaction outside of the class can be difficult for an instructor to observe and measure objectively. However, with the use of technology, teams can demonstrate fairly easily their level of interaction and division of tasks through tools such as the Hierarchy Chart tool in Word, MS-Excel and Project and Gantt Charts while improving their project management skills. Through Blackboard and Dropbox, students also are able to deposit their collaborative work and faculty may access remotely. This easy access made possible by technology, enhances the level of interaction of the teams and with their instructors (Warschauer & Grimes, 2005).

Consistent with the literature, many of the challenges faced during the project were technical in nature. Both students and instructors in the STEPS programme expressed concern about laptops frequently crashing or freezing due to graphics hardware or software driver problems affected by the size of software packages being used. (Autodesk, 2015). Security software slowing down or crashing computers has also been identified as a problem (Martin, 2016), but this was not an issue in our experience primarily because of the compatibility of institutional firewalls and other protection, and frequent review and updating of the same.

Battery life and power outlets have been recognized as other infrastructure issues affecting the classroom use of laptops (Zhu et al., 2011). This was also a problem identified by the instructors in our study especially given the issue of software such as Solid Works already mentioned. If students did not have batteries fully charged, then pressure on the available power outlets was high and instructors identified this problem as 'serious'.

Wi-Fi interference was another issue identified in some studies, with concern expressed that students spent time on social networking and email. This was not only distracting to the perpetrators but also those around them (Chun & Wolfe 2011; Zhu et al., 2011). Our classes are small and we work in ALP classrooms (see Figure 3 above), designed for group work. Teacher interaction with the students is therefore high and there is little space or opportunity for students to be engaged in activities other that those directly related to the learning task in hand. The 'attentional shifts' identified by Fried (2008, p. 908) were therefore not an issue for us. Lecture halls, on the other hand, often have a high level of such practice (Barak et al., 2006) but our experience was more consistent with the findings of Kay and Lauricella (2011b).

Training is commonly seen as a priority (Parr and Ward 2011, Martin 2016) and the focus here is often on the instructor (Ward and Parr 2010). In our case, a need for narrow-focus training was identified by both students and instructors in our study. Our use of instructional technology is generally well developed but both user groups identified a need for training on use of the stylus given the high level of touch sensitivity of the screen. Both courses participating in the study have a high frequency of lap top use already and teachers receive training in the application of educational technology in the classroom. This may explain why more generalized concerns about training were not expressed. Students, of course, become experts through experimentation, discovery and personal use. When students require in-class training, it is usually for a specific need and application. Here, they are given guidance by the teacher and the element of immediate use is a significant reinforcement for learning. (Hoy, Miskel & Tarter, 2013).

Conclusion and Recommendations

As a project, this one was measurably successful and generated useful findings which can be shared with faculty and students to enhance the use of this important learning technology in our classrooms and beyond. The technical difficulties encountered are, by and large easy to rectify. As already stated, the replacement of the laptops with Microsoft Surface Pro was an easy remedy for computer-crash and management of sizeable engineering drawing software packages. Changes to the supply outlets in the classrooms are likewise simple logistical issues and easily resolved. Timely

reminders to students to keep their batteries fully charged would alleviate pressure on the existing outlets until the requisite physical changes are made.

Some of the negative student responses on the advantages of using the laptops gives cause for concern. Qualitative data derived from follow-up interviews with students would likely enable an understanding of these perspectives which can then be responded to with adjustments in the areas of stated concern, including subject material understanding and feedback. Such follow up may well reveal that the issue here is not the technology, but could be related to pedagogical questions such as teacher methodology. This is significant in the light of concerns that too much focus on technology as a 'panacea' might distract from other, perhaps more important factors that influence learning. (Toyama, 2011). This would be a fruitful area for further investigation. Further, anecdotal evidence from teachers that 'learning improved' could be explored in a more robust research project aimed at investigating this perception in a more measured and structured fashion.

Students' apparent complacency on receiving the lap-tops was identified by one faculty respondent as probably related to their familiarity with the device from other contexts and uses. There is perhaps an issue here with front-loading sessions at the start of the course explaining the rationale for using lap-tops and involving the students in discussion and learning around the educational uses and applications of the technology, as well as the purposes for which it will be used in the courses. As clients, students need to be persuaded of the advantages, and their buy- in is very important at this early stage. Research and case studies could be shared with students to support the argument of advantage (Zhu, 2012).

With specific respect to engineering education, given the high dependence on computers in design modelling and real-time data collection, there is likely to be a more positive disposition towards the use of laptops amongst engineering students. Engineering education, in particular, is highly affected by the injection of technology into the classroom due to the reliance of engineering on such technology. Using laptops in the classroom proved to be helpful for the students as well as for the instructors by facilitating solutions, research and communication (Ohland & Stephen, 2005).

Finally, on the basis of this study, lap-top technology in classrooms like ours can be strongly argued for as a way of encouraging students to work in efficient and focused ways that increase the likelihood of addressing significant learning modes and outcomes including, teamwork, projects, research, communication and more. Additionally, the discussion amongst the teachers provided us with an opportunity to reflect on our practice with a view to development and improvement.

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