Faculty and Student Perspectives on Internet-Based Engineering Education

Kari L. Jordan[1], Anahita Pakzad[2] and Renee Oats[2]
[1] The Ohio State University, Columbus, OH, USA
[2] Michigan Technological University, Houghton, MI, USA

Abstract—**Internet-based engineering education is an accepted practice throughout the United States and abroad. The authors explore faculty and student perspectives on internet-based engineering education in terms of its ethical and societal implications. Are students who take courses via internet-based learning technologies more prone to cheating and plagiarism than those in traditional learning environments? Do students feel they are gaining the necessary knowledge in their courses and laboratory sessions to become successful engineers? Do their expectations of what will be asked of them on homework and exams reflect what is seen in industry? Are instructors of internet-based engineering education courses satisfied with the quality of work being produced by their students? These questions were explored via short interviews with faculty and students at a medium sized technological institution in the mid-western United States.**

Index Terms—**Engineering education, internet-based, IBEE, online learning**

I. Introduction

Internet-based engineering education (IBEE) has been in existence since the early 1990s, but distance learning programs in general began to sprout in the 1970s. The New Jersey Institute of Technology (NJIT) has been a pioneer in distance learning, creating the software and teaching methods used to support Americas first distance-learning courses. Additionally, the term Virtual Classroom® was copyrighted at NJIT.

Distance learning programs in engineering today are abundant. For example, the University of Illinois at Urbana-Champaign offers a Master of Science in Mechanical Engineering completely online. Through internet-based engineering education (IBEE) students are able to pace themselves, interact with instructors and their classmates, and participate in live feedback sessions. IBEE also accommodates students with various learning styles and physical disabilities. There are many positive features of internet-based engineering education (IBEE) such as a means to interactively present and disseminate curricula through coursework management tools such as Blackboard and Carmen. IBEE also promotes collaboration and continuing education for full time employees, i.e. "learning anywhere, anytime" [1]. Students are encouraged to expand their knowledge of the material being taught through media, images, animation and streaming audio/video. Because of these innovative teaching and learning opportunities one would think the number of engineering degrees being awarded to U.S. citizens would increase dramatically. This is not the case, however.

According to the U.S. Labor Department the unemployment rate in 2010 for all engineers was about 4.5%. Per President Barack Obama, "we've made incredible progress on education, helping students to finance their college educations, but we still don't have enough engineers." President Obama is pushing to train 10,000 new American engineers per year, but will those engineers be able to surmount the challenges in cyber security, sustainability, etc. if their degree programs are internet-based?

This paper provides the opinions of undergraduate students, graduate students, and faculty members regarding the ethical and societal implications of internet-based engineering education (IBEE). By exploring the ethical implications, the authors seek to understand how learning engineering by way of internet-based tools affects engineering students' competence performance. By exploring societal implications, the authors seek to understand how learning engineering by way of internet-based tools affects society and the engineering community as a whole. Specifically, the authors seek to understand if internet-based engineering education affects the quality of engineers being produced in society. Focus group studies and electronic surveys were used to capture the opinions of undergraduate and graduate engineering students, and engineering faculty members at a medium sized technological institution in the mid-western United States. Responses were compiled and are presented in this paper.

II. Internet-based learning in brief

What was once thought of as an "educational experiment" [6] to encourage student participation and promote the use of new technology is now a common practice in universities and colleges around the world. As early as the 1990s, teaching and learning with the internet has: increased student enthusiasm; provided an avenue for efficient data exchange; encouraged collaborative, student-led learning; promoted the discussion of course topics before, during, and after class; and offered a variety of learning environments [5, 6]. In its initial stages, internet-based learning was offered through e-mail lists, bulletin boards, and basic web sites [6]. In some

instances, those students receiving web instruction performed higher than those receiving traditional classroom instruction [6]. Notwithstanding, students viewed traditional educational approaches as important components to learning engineering successfully [5].

Internet-based engineering education (IBEE) has evolved from discussion boards and electronic homework submissions. Courses are now being offered via webcasts, podcasts (non-streamed webcasts offered via download through web syndication), and satellite broadcasts. These courses reach a larger student body and provide convenience and self-paced distance education [4]. The range of developments in internet-based courses encompasses web syllabi, asynchronous (student-centered) discussions, video conferencing, and simulated and real-time control [4]. Internet-based courses can be partially or fully offered online; thus, a range of interactions is necessary.

III. BACKGROUND: ETHICAL AND SOCIETAL IMPLICATIONS

Various options for teaching and learning with the accessibility of the internet exist. What effect does internet-based engineering education have on student learning? Does the type of web format affect a students' comprehension of the material? A study conducted at the University of Florida on the effectiveness of web formats on student learning showed no significant differences between constructivist learning (learners as active in acquiring their knowledge) and objectivist learning (reduces the learner to a passive role) [2]. In other words, the format of internet-based learning may not affect a technical students' comprehension of the information being taught.

What then can we say about the ethical and societal implications of internet-based engineering education? The success of an internet-based learning experience depends on community, pedagogy (style of instruction), interaction, and feedback [9]. From a student's perspective, although internet-based learning can be effective and rewarding, separating students taking the same course "hinders the development of interactions and the formation of a community of learners" [9]. From an instructor's perspective, implementing traditional pedagogical approaches provide students with familiar learning environments, allowing them to feel comfortable, although electronic delivery of lectures and course material requires greater preparation [9].

In general, faculty are satisfied with internet-based learning, and students are successful learning online [1]. Incidentally, the quality of engineers being produced by way of internet-based learning can be improved through collaboration between institutions and industry [1]. In terms of students' expectations of what they should be able to produce on homework and exams, if instructors provide clear definitions of course objectives and expected outcomes, students should be able to meet those objectives regardless of their learning environment [3].

Equally important are the issues of cyber ethics and plagiarism. Plagiarism occurs often in the online classroom by way of using other's opinions or theories, borrowing statistics or illustrative material, and submitting projects using others' material without acknowledgment [8]. To this end, it is the instructor's responsibility to help students understand the importance of academic integrity [8].

This discourse provided a background to shape an understanding of the ethical and societal implications of internet-based engineering education as summarized through current literature. Moving forward, the authors summarize the thoughts and opinions of undergraduate students, graduate students and faculty members in Mechanical, Civil, Electrical, Chemical, and Environmental Engineering at a medium sized mid-western technological institution to compare respondents' sentiments. The authors posit the results of the survey and group study will be similar to current research findings.

IV. METHOD AND RESULTS

To explore the opinions of students and faculty members on internet-based engineering education, ten questions were posed to 20 students and 5 faculty members. These questions were aimed at understanding the ethical and societal implications of internet-based engineering education (IBEE). The answers from the surveys and focus group discussions are summarized below.

Q1. What single word comes to mind when you hear the phrase "internet-based learning"?

Fig. 1 presents a word cloud of the responses received. Words including "new", "technology", "computer" and "webinar" were popular among faculty, while students mentioned words including "easy", "informal", "Google", "interactive", "freedom", "dedication", "opportunity", "infinite", "advancement" and "convenient". Negative words such as "unreliable", "boring", "disconnected", "stupid", "unacquainted", and "cheating" were also mentioned.

Figure 1. Word cloud of survey responses

Q2. What courses do you feel internet-based learning is most effective?

Responses were similar across the board with respect to undergraduate students, graduate students and faculty members. Fundamental and introductory level classes, ones that involve memorization of facts and a great deal of reading, and those that do not rely on real time responses, such as English, History, Foreign Languages, IT, Business and software tutorials were thought to be effective through internet-based learning. It was mentioned that math based courses and those courses involving lab work and dialogue may not be as effective as they could be if taught in a traditional classroom setting.

Q3. What is your definition of plagiarism? Is it possible to plagiarize through internet-based learning? How?

Both students and faculty were well aware of the definition of plagiarism and common copyright laws. They generally believed that it would be easier to plagiarize by submitting assignments through the internet rather than in an actual classroom setting because information on the internet is easy to access and open to the public. One faculty member maintained, "cutting and pasting is very common, and it is easy for students to forget their references." Additionally, when submitting assignments through the internet it is easy for a student to work in a group even when they are not allowed, to submit quizzes and homework multiple times until they receive full credit, or to submit an answer someone else has come up with without the instructor knowing.

Q4. Does internet-based learning (ex., submitting homework and exams on-line) make it easy for you to cheat?

Nearly all of the students answered yes to this question. A summary of the reason for their response is as follows: ***When you do not see your teacher or classmates in person, it is easier not to be accountable because most of the time grading is also done automatically. There are less ways for the instructor to notice something suspicious.***

Faculty seemed to have a different opinion. They believed that with internet-based learning there is always a record of all the students' work, which makes it more difficult to cheat. There were also some who figured students who want to cheat, will cheat, no matter what the situation is.

Generally, respondents felt the answer to this question depends on the situation. Internet based learning takes place in a mildly controlled environment, and cheating is easier during exams.

In summary, each group agreed that it is easier to cheat in an internet-based course, although cheating in traditional classroom settings is possible, too.

Q5. What expectations do faculty set with respect to internet-based learning?

Faculty members mentioned that they do not set any different expectations from students in a traditional classroom setting, but in an internet-based course, they assume that students can use technology and that they have enough discipline to keep up with the class.

Students had interesting answers to this question. It seems that they believe faculty do not know much about internet-based learning, and they believe students are cheating all the time, so they have minimal expectations from students.

Q6. What are some examples of safe and easy to use internet-based learning tools? What types of features do these tools offer?

Blackboard, Echo360 and Connect pro, problem solving calculators, spell check and online dictionaries were some of the examples mentioned. Respondents feel these tools are great for sharing class material (documents, lecture slides and notes, web links, etc.). They make it easy for faculty to provide information for students, and students can easily submit their exams and homework anywhere, anytime.

Q7. How do you think students perform who take classes on-line (via watching lectures on the web or recorded videos) compared to students who are physically in the classroom?

In general, respondents felt those who attend classes in a traditional classroom setting perform better than those who take classes online because: students do not have the discipline needed for following online class instruction; in online learning environments students do not use as many senses as they use in a traditional classroom setting, thus they do not learn as much; attention is divided while students listen to an online lecture; and more importantly students learn through their interactions with faculty and their fellow students. They may not have these opportunities through internet-based learning.

It is also worth noting that this comparison (internet based learning vs. traditional classroom setting) may be biased. When answering this question many mentioned that the class subject is important (factual or hands-on techniques), the size of the class is important, each person learns differently (some need to sit in a class, while others just need a book in hand) and that online learning makes it easier for students to cheat and get higher grades compared to students in a traditional classroom setting. Comparing only grades is not conclusive. Students and faculty tend to believe that even if both groups earn the same grades, long term retention is going to be higher in the students who sit in a classroom and interact with others.

Q8. Does internet-based learning help foster strong peer-to-peer relationships and collaboration?

In general, students and faculty were neutral on this subject. They all agreed that relationships depend on the individual, and that it is always easier to make friends in person.

Q9. Does the quality of internet-based learning depict the 5 pillars shown?

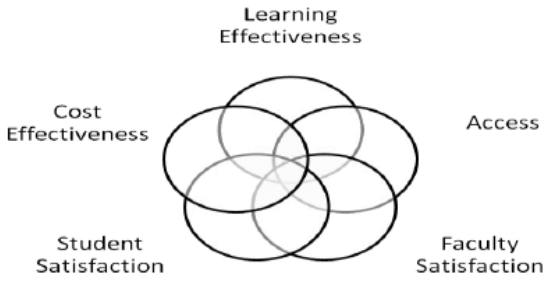

Figure 2. The five pillars of online learning [5]

Access: The general consensus was that internet-based learning provides easy access to knowledge.

Faculty Satisfaction: Faculty satisfaction seems poor. Most instructors enjoy teaching because it involves one-on-one interaction with students. This is minimal when teaching internet based courses.

Student Satisfaction: Students enjoy internet-based learning because they can work from the comfort of their homes at their leisure. This type of learning environment specifically appeals to working students.

Cost Effectiveness: Internet based learning is definitely viewed as being more cost effective than attending college courses.

Learning Effectiveness: Based on the course being taught and individual student learning, effectiveness may vary, but the fact that students can watch a lecture multiple times may increase their learning and memory.

Q10. Is internet-based learning affecting the quality of engineers being produced in society?

It is not surprising to find that everyone participating in our study believed engineers need hands-on experience and to work in teams to learn the analytical skills needed to become successful engineers. Engineers also need social skills to be successful. Face-to-face interaction in the classroom provides these skills, while internet-based learning lacks these factors.

V. CONCLUSIONS AND FUTURE WORK

Internet-based learning is definitely a growing option for engineering educators and students. It is a subjective debatable option in which the implications for the university environment and its interaction between the students and faculty should be considered. Along with this interaction, the ethical and society implications it has on the university community is of great interest. This paper aimed to address these implications by summarizing the responses of those directly involved in internet-based learning, engineering undergraduate and graduate students as well as engineering faculty members. The authors realize these findings may depend on the tenure of the faculty being surveyed, type of institution under consideration, and caliber of engineering student (i.e. are they responsible? Self-disciplined?). In engineering studies on internet-based learning, research has shown that there was not much difference in the quality of education whether a student participates in an active (in class) or passive (video streamed) environment [2]. The format of the information taught is not considered an integral factor in internet-based learning technology. Therefore, this leaves the responsibility on the individual student to be disciplined and keep up with the organization of their internet-based course. Moreover, as the format may not be a factor, perhaps the actual content of what is being taught may be something to consider when considering internet-based learning's effectiveness.

The general consensus from the focus group studies and surveys about internet-based learning in engineering was that students were satisfied with the flexibility and general cost of this type of instruction. Faculty felt it was less satisfying than in-class instruction. Nonetheless, both groups feel that accessibility is paramount. It is also agreeable among the groups that this type of learning is more suitable for introductory or lower level courses than those of more technical and laboratory background. Also, classes that require more writing (e.g. English and History) and computer based (e.g. Programming or Information Technology) seem suitable for internet-based learning.

The effectiveness of internet-based engineering education (IBEE) is an important topic with respect to its social implications on the university community. The general synopsis of the learning effectiveness of internet-based engineering education is that it depends on the student taking the course. It was regarded that those in a traditional classroom setting perform better than those watching a streaming internet video. Consider also if the student repeatedly reviewed material readily accessible on the internet that may not be otherwise available for those taking in-class instruction. They have an obvious advantage as repeatedly watching lectures may improve long-term memory with respect to the information being taught in the lecture. Additionally, IBEE was questionable in terms of its ability to foster peer-to-peer relationships.

When considering words that come to mind when hearing the phrase "internet-based learning" it is no surprise that there are varied reactions. This helps us understand the ethical implications of internet-based engineering education. When considering this form of learning technology, most students felt it allows an easier way to cheat and plagiarize as there is no in-class proctor or monitor. Notwithstanding, this technology provides creative ways to inspect typed work and easily identify plagiarized assignments.

It was also mentioned that it is the faculty's responsibility to implement academic integrity policies and expectations; however, faculty feel that their expectations are not any less than those of in-class instruction. It was reported that faculty who have taught internet-based engineering courses also assume their students will be able to discipline themselves in the internet-based learning environment and can effectively use the technology. On the contrary, most of the student respondents felt that there are not many expectations instilled on the students in internet-based engineering education. It seems there needs to be clear objectives and standards of internet-based engineering education to avoid misunderstandings and misinterpretations.

As we posited, the results of the survey and group study are similar to current research findings. A long term concern is the quality of engineers that are produced through internet-based engineering education (IBEE). Both faculty and students feel that engineering students need hands on experiences and personal interactions. In industry, social skills are needed for interaction in the field. As technology continues to advance, internet-based learning is likely to grow among campuses. As long as safe and interactive tools are implemented, a welcoming internet-based environment may drive the future of internet-based engineering education.

Future work requires the creation and validation of an assessment that can be used to determine the effectiveness of internet-based engineering education compared with the traditional classroom setting. Factors to be addressed in this assessment include but are not limited to duration of class sessions, class structure/format, and student background information (i.e. ACT score, class rank).

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AUTHORS

Kari L. Jordan is a doctoral student in Engineering Education at The Ohio State University, Columbus, OH, 43210 USA (e-mail: jordan.722@ osu.edu). Jordan earned bachelor's and master's of science degrees in Mechanical Engineering at Michigan Technological University. Her doctoral research focus is engineering self-efficacy of first year minority engineering students. She is a former GEM Fellow and King-Chavez-Parks Future Faculty Fellow. Jordan currently serves on the board of directors for the National Society of Black Engineers (NSBE) as National Vice Chairperson. She has been a member of the American Society for Engineering Education (ASEE) since 2008 and has served as the Michigan Tech Chapter President.

Anahita Pakzad (e-mail: apakzad@mtu.edu) received a bachelor's degree in civil engineering from KNT University of Technology in Tehran, Iran in 2007. As a mechanical engineering doctoral student at Michigan Technological University her work includes nanomechanical properties of the interphase in polymer composites.

Renee Oats is a doctoral candidate in Civil Engineering at Michigan Technological University, Houghton, MI 49931 (e-mail: roats@mtu.edu). Her research is on structural health monitoring of bridges and modeling bridge behavior. Oats is a former National Science Foundation Fellow and member of various engineering and education societies including the American Society for Engineering Education (ASEE).

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