Faculty and Student Perceptions of Online Learning in Engineering Education

Abstract

The number of distance education programs at the university level has been rapidly growing. Studies have shown that the penetration of online courses is generally equal in most disciplines except for engineering. In addition, research indicates that attitudes and perceptions are critical to the acceptance of new technology. Therefore, a mixed methods exploratory study was conducted to investigate faculty and student perceptions of the effectiveness of engineering courses delivered online and specific technologies used in online courses. A convenience sample of students and faculty involved in online engineering courses from three universities in the southern United States were surveyed and a subset participated in follow up interviews. Results show faculty and students agree effective communication is a key concern, technical subjects can be effectively delivered via online methods, and engineering labs are a hurdle to effectively delivering engineering education online.

Introduction

The implementation of distance education programs at post-secondary institutions has been rapidly expanding, with the National Center for Education Statistics reporting that 66% of US 2-year and 4-year programs offered some sort of distance education program, including online, hybrid, or some other distance education courses[1]. The Sloan Consortium focuses on online course offerings and indicates that 96% of the largest institutions have some online offerings and 66% of them have fully online programs. Over 3.9 million students took at least one online course during the fall 2007 term[2,3]. The penetration of online courses is generally equal for most major discipline areas (business, liberal arts and sciences, education, etc.); however, engineering programs have a significantly lower implementation rate[3].

Given the adoption rates of other disciplines and indications in the literature that online and distance methods are at least as effective as face-to-face methods, this research explores possible reasons for the low adoption rate in engineering programs, specifically through analyzing the perceptions of engineering faculty and students toward online engineering education.

Review of Literature

The concept of teaching at a distance, or distance education, has a long history. Distance education has been described as the use of technology "to deliver instruction and learning freed from the geographical and time constraints associated with face-to-face instruction."[4]. Many different technologies have been employed in this manner over time, from printed books and educational materials sent through the mail, to radio and audio recordings, to live and recorded television, and now to the 'fourth wave' of distance education – computer and internet technology. Instruction delivered via the Internet has become the preferred mode of distance education[5].

As student demographics have changed, many colleges and universities have employed various distance education strategies to expand their offerings to 'non-traditional' markets, including students that are older, married or with families, or working part- or full-time. Due to these various demands, many of these students are not able to attend on-campus courses during regular course times. They require flexibility in time and place, and institutions are working to address these needs by offering courses online [4,5,6].

The online distance education course experience can be very different from a classic classroom environment. There is little or no face-to-face interaction, video or text-based information delivery can limit the richness of communication, and other methods of synchronous and asynchronous communication can limit student-instructor and student-student communication. In addition, technological issues can interfere with the learning process[6].

Given these differences from traditional teaching methods, it seems reasonable to question the effectiveness of distance education methods. However, a number of studies have demonstrated that distance and online delivery methods are at least as or more effective than face-to-face methods in terms of student outcomes[7,8].

Research shows that if individuals think a particular technology is useful in their work then they are more apt to adopt and use that technology[9,10]. Tanner et al.[6] point out that student and faculty comfort with online learning is impacted by their attitude and perceptions of online learning. Faculty acceptance is key to the success of online programs, so understanding these attitudes and perceptions is critical if online programs in engineering are to proliferate[4].

To help understand the role of perceptions in the adoption of new technologies, the Technology Acceptance Model (TAM) was developed by Davis[9] and has since been further modified, expanded, and refined as the TAM2[11]. The TAM theorizes that the intention to use a particular system is composed of two primary factors: perceived usefulness and perceived ease of use. Perceived usefulness is defined as "the extent to which a person believes that using the system will enhance his or her job performance" and perceived ease of use is "the extent to which a person believes that using the system will be free of effort"[11].

The TAM and its subsequent iterations have been shown to explain a substantial proportion of the variance in usage intention. Of the two factors, perceived usefulness has been shown to correlate strongly with usage behavior and ease of use is a significant secondary determinant[9,11]. Essentially, this means that if users of a system do not perceive it as useful, they are unlikely to use it. In addition, even if they perceive the system as useful, they may believe the system is too difficult to use and will therefore be less likely to use it. It is important to note that all of these factors are perceptions and not measures of an objective reality. These are the opinions of the user, however they are developed, and not reflections of the actual functionality or applicability of a system to a given task.

Studies in a wide variety of technology fields, including computer languages, information systems, and communication technologies have all been supportive of the TAM and the distinction between usefulness and ease of use[9]. Research in educational technology and distance education has also utilized the TAM or similar analyses of user perceptions. Lee, Cho, Gay, Davidson, and Ingraffea[12] explored the TAM model and social networking in a distance education project for aerospace design. Landry, Griffeth, and Hartman[13] looked at student perceptions of the Blackboard ™ learning management system.

Other research has focused directly on the role of perceptions in online courses. Osborne, Kreise, Tobey, and Johnson[14] developed a survey instrument to investigate student and faculty perceptions of online courses in social science departments. This study found that effective communication methods are critical for online courses.

It is clear that faculty and student perception is a key component in the acceptance and implementation of new technologies, including online and distance education programs, and it is important to explore these perceptions to understand the reasons behind the low rate of implementation in engineering programs. In addition, concerns about tool and technology issues and their applicability to engineering distance education could play a role. Therefore, the following research questions are proposed to investigate faculty and student perceptions of online education:

1. What are the perceptions of engineering faculty and students about online engineering courses?
2. What are the perceptions of engineering faculty and students about different technologies and educational methods employed in engineering courses delivered online?

Method

Data was collected via an online survey delivered to a convenience sample of graduate level engineering faculty and students from three major universities in the southern U.S. and follow-up interviews were conducted with an available subset of participants from one of the programs. Two universities are large public universities and one is a smaller private university. All three have accredited undergraduate engineering programs, offer Masters and Doctorate level engineering degrees, and offer some graduate level online courses. One university offers a complete graduate engineering degree program online.

The survey was originally distributed by e-mail during the Fall 2010 semester along with several reminder notifications. Due to the limited number of responses, the survey period was extended to include the Spring 2011. Follow-up interviews were conducted during the Fall 2011 semester.

As noted previously, Osborne, Kreise, Tobey, and Johnson[14] developed a survey instrument to investigate student and faculty perceptions of online courses (hereafter referred to as the “Osborne Survey”). Their research did not focus on engineering courses, but rather included students and faculty from social science departments. The Osborne Survey has been adapted for this study and has been modified to specifically evaluate perceptions of online engineering courses. Ten of the items were used verbatim, and two items from the original survey that were not relevant to the current study were removed and replaced with questions more specific to engineering education.

Additional questions were added to the survey to explore perceptions of effectiveness of several different online educational technologies and methods, such as video streaming, text chat, blogs, etc. The full survey is included in Appendix A.

The survey was adapted to be delivered via an online survey tool, and was divided into three sections. The first was a demographic section to collect basic information on gender, faculty / student role, engineering program, and experience in distance education courses. The second section consisted of 12 questions based on the Osborne Study to evaluate faculty and student perceptions of online courses. Reponses were measured using a 5-point Likert scale (1=Strongly Disagree, 5 = Strongly Agree). The third section consisted of a list of 15 individual technologies or tools used in online education and respondents were asked to provide their impression of the effectiveness of each using a 5-point Likert scale (1=Very Effective, 5=Very Ineffective) plus an option to indicate the respondent had no experience with the item. If it was indicated that the respondent had no experience with the item, the response to that individual item was removed from the analysis. Since the direction of this scale – a low value indicated a positive response and a high value indicated a negative response – was the reverse from the scale in the previous section, values from the actual survey were reversed and re-coded prior to data analysis to reduce confusion.

It should be noted that the items based on the Osborne Survey in the second section were not specifically designed to evaluate any particular parameter of the TAM model such as either perceived effectiveness or perceived ease of use. Rather, the questions were intended to evaluate perceptions of online education in general. In addition, Osborne[15] reported that each item in his original survey was considered to be independent.

At the conclusion of survey data collection and analysis, it was determined that a small number of follow-up interviews would be beneficial to further explore the results of the survey. A set of interview questions were developed based on the results of the survey. These questions included demographic information, a general question about advantages and disadvantages of online courses, and then questions exploring the respondent’s opinion about certain outcomes from the survey. The interviews lasted approximately 30 minutes and were semi-structured with initial prepared questions and follow-up questions as needed. The interview questions are included as Appendix B.

Procedure

The study was conducted in two parts. The first part was an online survey and the second part involved follow-up interviews with a small group of faculty and students to further explore and expand upon the results of the survey.

The survey was delivered electronically using a popular online survey tool. E-mail invitations were sent to faculty members identified by each institution as teaching a graduate level engineering course online. Since the institutions did not disclose the email addresses of students enrolled in online course, the invitation requested that the faculty member forward the survey to each of their students. The survey response rate was monitored and several reminders were sent throughout the semester.

Survey results were downloaded from the online survey tool and imported into SPSS, where statistical analyses utilizing independent t-tests were performed to compare the main two respondent groups (all faculty, all students) for each item. The t-test was selected for this analysis due to its use in the analysis by Osborne, Kreise, Tobey, and Johnson[14] and the need to compare the results of this survey to the results from the similar questions from the Osborne Survey. An alpha level of 0.05 was used for all statistical tests.

After the survey results were analyzed, the interview instrument was prepared as described previously. A small sample of faculty and students were interviewed on campus and the interviews were recorded. The interviews were then transcribed and the transcripts coded by one of the authors using a popular qualitative analysis tool. During initial coding, the reviewer looked for themes and concepts across the interview questions, as well as coding themes within responses to specific questions. The resulting codes were reviewed by the other authors to verify accuracy. A final round of focused coding was then performed to eliminate and combine any similar codes with an eye toward emergent large scale themes.

Results

Surveys were sent to faculty members identified by engineering program administrators as graduate level instructors of online or distance courses. A total of 48 faculty members were contacted and 18 responded. One indicated that they are not interested in participating and one did not complete the survey, making the current sample response a total of 17 of 47 contacted for a response rate of 36%.

Due to concerns over releasing student email addresses, each instructor was asked to forward the survey link to the students in their online engineering classes. It is unknown how many of the faculty members actually forwarded the survey to their classes or the total count of students per class; therefore it is not known how many students were ultimately contacted. A total of 30 students have responded to date representing an unknown response rate. Two students started but did not complete the survey, leaving a total of 28 student responses.

After the survey results were analyzed, a convenience sample of three students and two faculty members were selected for follow-up interviews using the instrument and the procedures mentioned previously. The initial coding resulted in 38 different codes, which were reviewed, combined, and revised into a final list of 35 codes grouped into 19 categories. Of these, 13 categories are related to responses to specific interview questions. A few codes and coding groups emerged as primary themes, both across the individual questions and across the interviews as a whole: synchronous vs. asynchronous communication, interpersonal communication, and technology issues and tools. The interpersonal communication grouping had the most related interview passages, and also contained three key sub-groupings: student and faculty interactions; student to student interactions; and the ability to ask questions.

Demographic responses from the survey were compiled and are presented in Table 1. While the survey was targeted at graduate level faculty and students, one faculty member and one student respondent indicated that they are involved at the undergraduate level. These responses were included in the sample since some engineering programs taught at the graduate level allow upper division undergraduates to take the same course as graduate students and are cross-listed in the course schedule.

The gender of survey respondents seems to be skewed strongly toward male engineering students, which matches data reported by Gibbons[16] that approximately 23% of engineering graduate degrees are awarded to women. All interview subjects were graduate level students and faculty, with one male and two female students and one female and one male faculty member.

Table 1
Survey Responses: Demographics

	Gender		Level		Enrollment Status	
	Male	Female	Grad	Undergrad	Full Time	Part Time
Faculty (n=17)	15	2	15	1 *	--	--
Student (n=28)	21	7	27	1	6	22

* One faculty respondent did not indicate teaching level.

Experience level of respondents was collected and analyzed. Faculty experience with online education was indicated by the number of engineering courses taught using online methods. Respondents reported a large range of experience levels, with the mean of 7.5 courses (SD = 7.67). Student experience was indicated by the number of hours they have completed in their program, with a mean of 17.71 hours (SD = 12.62). This matches the number of courses students reported having taken online, with a mean of 5.04 courses (SD = 3.72). These results indicate that the student and faculty respondents were familiar with online engineering courses and responses were based on personal experience with this type of course delivery.

The branch of engineering for each respondent was also collected. Almost 70% of respondents reported being either faculty or students in petroleum engineering, with others indicating computer, electrical, engineering management / systems, environmental, industrial, or mechanical. The preponderance of petroleum engineering respondents is indicative of the makeup of the convenience sample and that one of the participating institutions has a graduate level online petroleum engineering degree program.

The first research question concerns the perceptions of students and faculty about online engineering courses and if those perceptions differed between the groups. Within group descriptive statistics were calculated and the responses from faculty and student groups were compared using an independent sample t-test (See Table 2).

Table 2
Comparison of Student and Faculty Perceptions of Online Engineering Courses

	Faculty Mean (n=17)	Student Mean (n=28)	Significance
Online Easier	2.06	2.37	.348
Students Learn Less in Online Courses	2.47	2.71	.538
Students Speak Less in Online Courses	2.47	3.25	.028*
Online Allows More Communication	2.82	1.93	.008**
Online Takes More Time	2.47	3.32	.013*
Online Fewer Opportunities to Interact	3.76	4.21	.244
Online Less Effective Interactions	3.88	4.14	.442
More Problems Online	2.65	3.18	.151
Online Students Withdraw More	2.59	2.78	.514
Procrastinators Should Not Take Online Courses	3.63	3.61	.960
Technical Topics Can Be Taught Online	4.06	4.25	.524

Engineering Labs Cannot Be Taught Online	3.47	3.79	.386

Scale: 1= Strongly Disagree / 3=Neither Agree Nor Disagree / 5= Strongly Agree
* Significant at $p < 0.05$
** Significant at $p < 0.01$

These results indicate a statistically significant difference in perceptions of communication and workload issues in online courses between faculty and students on three items: students speak less in online courses; online courses allow more communication; and online courses take more time.

The second research question is related to perceptions of effectiveness of certain online technologies and methods. Within group descriptive statistics were calculated and the responses from faculty and student groups were compared using an independent sample t-test (See Table 3). This section of the survey also included "I have no experience with this item" as a possible response. These items were removed from the analysis, so some of the response populations on individual items are actually much smaller than the total population for each group.

Table 3
Comparison of Student and Faculty Perceptions of Online Technology and Methods

	Faculty Response (n)	Faculty Mean	Student Response (n)	Student Mean	Significance
Streaming Online Video	15	4.27	21	3.67	0.074
Recorded Online Video	17	4.24	28	4.36	0.559
Online Course Materials	16	4.38	28	4.18	0.429
Course Website	16	4.25	25	4.16	0.724
Online Exams	15	3.67	25	3.80	0.674
Discussion Boards	16	3.94	27	3.33	0.044*
Text Chat	15	3.67	20	2.75	0.016*
Audio / Video Chat	12	3.42	17	3.29	0.636

Online Analysis Software	11	4.09	16	3.75	0.339
Stand-Alone Analysis Software	13	4.31	21	3.86	0.074
Virtual / Remote Labs **	8	3.00	7	3.14	0.800
Online Simulations	11	3.73	10	3.50	0.532
Blogs	8	3.13	13	2.85	0.558
Social Networking	7	3.29	16	2.69	0.317
Virtual Worlds **	5	3.00	8	2.88	0.812

Scale: 1= Very Ineffective / 3=Neither Effective Nor Ineffective / 5= Very Effective
* Significant at $p < 0.05$
** Low Response Rate / High Indication of 'No Experience With This Item'

Faculty responses ranged from neutral to positive in their perception of all online tools and methods. Students responses differed from faculty responses on only two items: discussion boards and text chat. Both faculty and students agreed that discussion boards were effective to some extent, with faculty indicating a stronger positive impression of their effectiveness. The response for text chat is interesting in that faculty indicated a perception that text chat is a rather effective communication tool while students indicated a less favorable opinion. Additionally, there was a low response rate and a high indication that both faculty and students were not familiar with both virtual world applications and virtual or remote lab systems.

Discussion

The results and analysis of the survey and the follow-up interview responses show some interesting results, both in the perceptions that faculty and students seem to share and in the items that the groups perceive differently.

The statistical comparison of survey results concerning perceptions of online engineering courses indicated that for the most part this exploratory sample did not differ on most of the items. There was a significant difference in perceptions of online engineering courses between faculty and students on three questions related to communication and workload issues. Students were more likely than faculty to agree that:

1. Students are less willing to speak their mind in an online class than in a face-to-face class;
2. Students communicate less in an online class than they do in a face-to-face class; and
3. Online courses require more time for students to complete successfully than face-to-face courses.

The follow-up interviews provide a bit of insight into possible reasons for each of these positions. Regarding student willingness to speak their mind in an online class, both students and faculty commented that it might not be that students are less willing to speak, but rather that it can be more difficult to speak your mind or ask questions due to the format of the course or the communication technology involved. Therefore, while the perception could be that students communicate less and are therefore less willing to do so, there could actually be an issue with the methods used to communicate. For example, one faculty member responded that, "it is a little more effort when you've got to email me or somehow get in touch with me and some students may feel a little intimidated by that." Another opinion was that due to the asynchronous nature of some distance education coursework, whether watching a video of a lecture or using an on-line tutorial, a student may think and re-think sending a question to the instructor or sharing an idea with fellow students, as opposed to simply raising their hand spontaneously in a face-to-face course.

The survey results indicate that students think there is less communication in online courses compared to faculty perceptions. The interview responses for this item were more qualified and both faculty and students generally responded that 'it depends'. Again, the constraints of technology were mentioned as well as the perception that there might be less spontaneity in student responses due to the need to write and send an email or post to a discussion board. However, one student described a scenario where there the asynchronous nature of discussion boards and email allowed for more communication than might occur in a face-to-face class. Instead of students only communicating during class or lab hours on a project, they could communicate continuously as they were available, adding that having everything written and available online reduced confusion and miscommunication between team members.

For the final item, that online courses take more time, again the student and faculty interview responses were mixed. Faculty members indicated that online courses should not take longer than a similar face-to-face course since the materials are the same, and any recorded lectures would be of the same duration. In addition, they indicated that some online students are working part- or full-time, so scheduling could be an issue and finding time could lead to the perception that the course material takes longer to complete. One student raised an issue related to the asynchronous or remote nature of online delivery, namely that you cannot immediately ask clarifying questions to fellow students and faculty, and therefore may spend more time reviewing materials or searching for answers that could be asked on the spot during a face-to-face class or lab.

In addition to the differences in perceptions between faculty and students, there is important information in the perceptions that each group seem to share with the other. These results present a mixed bag of concerns with online learning methods. Survey results indicate that students and faculty seem to agree that online engineering courses are not easier than face-to-face courses and that organization and motivation are needed to succeed in an online course. The concern about individual motivation echoes the literature about issues with online education[2]. However, both groups agree that there does not seem to be a higher rate of students withdrawing from online courses.

Other survey results are supported by interview responses, with the topics of scheduling and planning as critical to success in online courses and issues such as student-student and student-faculty interaction named as potential hurdles. However, one issue raised by students as an advantage of online courses was the increased ability to review materials for homework or prior to exams, whether online lectures or written materials, than might be available in a face-to-face course.

Several survey items indicate that both groups have concerns with the quality of communications and the number of opportunities to interact in online courses. Faculty and students agree that online courses have fewer opportunities for communication as well as less effective communication than face-to-face courses. This is an important result that matches concerns raised in Osborne et al.[14]. These results are supported by the interview responses, with both faculty and students indicating that student-student and student-faculty interaction is critical and that it can be difficult to ask questions or clarify information in an online course.

The perception by faculty of less effective communication could be a potential hurdle for the continued adoption and implementation of online courses and the same perception by students could lead to lower enrollment or participation in online courses. However, the interview responses indicate that while interpersonal communication is a concern, neither the students nor faculty members interviewed saw this issue as a reason not to teach or take online engineering courses. An example raised both by a student and a faculty member was related to the difficulty in communicating issues related to drawing or presenting information via graphics in distance correspondence. While images can be transmitted electronically, when trying to explain or understand an engineering topic, "you want to draw the picture and say this is how I understand what we are talking about." Such concerns indicate that more work is necessary in the development and implementation of technical and pedagogical methods for rich and engaging communications in online courses.

It is also important to note that students and faculty in both the survey and in the interviews agree that online courses are at least as effective as face-to-face courses. This factor is key for the continued adoption of online learning in engineering and is in agreement with previous research on the effectiveness of online learning[7,8].

Both faculty and students seem to feel strongly that technical topics can indeed be effectively taught online. The concern that engineering or other mathematics intensive disciplines are not well suited for online learning has been expressed in the past, but engineering programs that offer online courses or complete programs like those surveyed in this study and others indicate that this perception may be slowly changing[17].

In contrast to the perception that engineering topics can be taught online, survey results indicate that both groups seem to feel that engineering lab activities cannot. This concern has also been raised in the literature[8,17,18], and seems to be one of the most significant hurdles to implementing online engineering education. Interview respondents also had concerns with labs, noting that some require specialized equipment. However, they also discussed advantages of simulations and software solutions. They also pointed out that some disciplines of engineering, such as electrical or computer engineering, are well suited for online delivery, while others are not. One faculty member provided an analogy with learning to drive a car. "You have these driving simulators that you can do all day, but you still have to get behind the wheel eventually, if you really want to drive the car and get the feel of it." This is an area ripe for additional research into effective technological and pedagogical solutions to the online delivery of engineering lab courses.

Since this portion of the survey was based on a study by Osborne et al.[14], it is interesting to compare the results of both studies (see Table 4). While this study focused on engineering programs, the Osborne Study focused on students and faculty in social science programs.

Table 4
Study to Study Comparison of Items Indicating a Differences in Faculty and Student Perceptions

Current Study	Osborne et al.[14]
Online Takes More Time	Online Takes More Time
Students Speak Less in Online Courses	Online Less Effective Interactions
Online Allows More Communication	More Problems Online
Students Learn Less in Online Courses	Procrastinators Should Not Take Online Courses
	Students Learn Less in Online Courses

The only result that overlapped between studies was the perception that "Online courses require more time for students to complete successfully than face-to-face courses." However, while both studies indicate that faculty and students differ in their perceptions of the amount of time required to be successful in online courses, a comparison of actual mean scores show that the two groups disagree on this item between studies. In the study by Osborne et al.[14], faculty indicated that they believe online courses require more time ($M = 3.75$) while students indicated that online courses do not ($M = 2.79$). The results from the current study are inverted, with faculty indicating that online courses no not require more time ($M = 2.47$) while students indicate that it does ($M = 3.32$). It is important to note that an independent t-test comparison could not be done between studies without having the full data or variance statistics from the Osborne Study.

However, it is still an interesting point that while students and faculty perceptions of the amount of time required in online courses differ, individuals in different programs (social science versus engineering) apparently see this issue in different ways. Additional study to address this particular issue is required to draw any further conclusion.

The underlying causes for differences between engineering and social science programs are not readily apparent from this survey. Causes could include the type of content or requirements of the different areas being studied, the pedagogical methods being employed, or some other issue related to online program delivery. This area is ripe for additional study.

The second research question is related to perceptions of effectiveness of certain online technologies and methods. In general, the survey results indicate both faculty and students felt that most online technologies were effective or at least not ineffective, and faculty had an overall more positive view of most items.

Students and faculty agreed on four of their top five ranked tools and methods, while the items each group ranked as the least effective differed (see Table 5). These items are some of the ones most commonly employed in current distance learning courses[5,19]. Most universities employ some sort of learning management system such as Blackboard ™, and with the expansion of broadband and wireless internet on campus and in homes the ability to deliver video and audio materials has increased. While it is reassuring that faculty and students perceive that current online tools are effective, it is important to remember that this survey cannot differentiate between perceptions based on familiarity and actual effectiveness of a particular technology.

Table 5
Student and Faculty Perceptions of Most and Least Effective Online Instructional Tools

	Faculty	Students
Most Effective	Online Course Materials	Recorded Online Video
	Stand-Alone Analysis Software	Online Course Materials
	Streaming Online Video	Course Website
	Course Website	Stand-Alone Analysis Software
	Recorded Online Video	Online Exams
Lease Effective	Virtual Labs	Social Networking

	Virtual Worlds	Text Chat

It is interesting to note that faculty members indicated that the least effective tools involved ‘virtual’ technologies – virtual labs and virtual worlds – and that few faculty members indicated that they had experience with these tools. Esche[18] has reported work on virtual and remote control labs in engineering and science courses, so this result points to an area of potential improvement or continued study to address the online engineering lab issue.

Students, on the other hand, indicated that two communication tools – text chat and social networking – were the least effective. These tools, along with other web-based or mobile communication tools such as blogs, wikis, and text messaging, are often discussed as student-friendly communication methods that instructors should attempt to incorporate into modern classrooms[12,19,20]. This result seems to encourage a review and evaluation of current communication methods with an eye toward implementing the tools that are most effective and not simply the most popular.

Limitations

This was an exploratory study with a limited number of faculty and student respondents. The survey was sent to a convenience sample of graduate level engineering programs in the southern U.S. and only a small number of students and faculty members were interviewed. The survey questions did not attempt to support or test any particular hypothesis or model. Rather, the intent was to collect initial data on perceptions to provide direction for further study.

The survey only asks about the perceptions of the respondent and not about any particular motivation behind the responses themselves. Follow-up interview questions were asked about individual experiences in online education and individual experience with particular tools. All of these are areas for future study, possibly through more focused and in-depth survey and interview work investigating experiences and motivations of a much larger and more diverse sample of faculty members and students across a larger number of engineering programs.

Conclusion

While this study is exploratory in nature, it still provides some interesting results for consideration and areas for additional research in online engineering education. The result that both students and faculty believe that technical topics can be effectively taught via online methods is critical for the future of online engineering education. When combined with the result that online courses are seen as effective as face-to-face courses, this is a significant result in favor of online engineering education.

A common concern of the respondents is related to overall effective communication in online courses, both synchronous versus asynchronous communication and interpersonal communication issues. Improving communications technologies and methods is key for the adoption and acceptance of online courses. The most common currently used online technologies (recorded audio/video, online course materials, and course websites) seem to be perceived favorably, possibly due to familiarity and ease of use, while newer Web 2.0 technologies (blogs, social networking, virtual worlds) are either viewed less favorably or students and faculty are simply not familiar with them. This is an area that all online educators and course developers, not just in engineering, needs to continue to study.

A significant hurdle to the increased acceptance of online engineering course delivery seems to be the perception by both faculty and students that engineering lab experiences cannot be delivered online. This should be an area of focus for engineering and educational researchers with an eye toward finding solutions that are technologically feasible, cost effective, and educationally sound.

In order to move more engineering programs and courses toward online delivery, there are several challenges that need to be addressed. If administrators, developers, and technologists are more aware of faculty and student concerns with current online course delivery methods, then they can focus their efforts to develop and improve the most effective tools for online engineering courses. This is a key first step to expanding the implementation of online education in engineering.

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Appendix A

Survey Form

1. Gender: Male / Female
2. You are: Faculty / Student
3. You are: Undergraduate Faculty or Student / Graduate Faculty or Student
4. Enrollment Status (Students Only): Full Time / Part Time
5. Have you ever taught or taken an engineering course online? Yes / No
6. How many hours have you completed in your program (including this semester)? (Students Only)
7. How many engineering courses have you taught / taken online?
8. Program Area / Major
    a. Civil Engineering
    b. Computer Science / Engineering
    c. Electrical Engineering
    d. Engineering Management / Systems
    e. Environmental Engineering
    f. Industrial Engineering
    g. Mechanical Engineering
    h. Petroleum Engineering
    i. Software Engineering
    j. Other
9. And 10. [Split for ease of display in survey tool.]
   Use the following rating scale to assess your agreement or disagreement with each of the following statements about engineering courses delivered online.
    1 – Strongly Disagree
    2 – Somewhat Disagree
    3 – Neither Agree Nor Disagree
    4 – Somewhat Agree
    5 – Strongly Agree

    - Online courses are easier than face-to-face courses.
    - Students learn less in online classes than in face-to-face classes.
    - Students are less willing to 'speak' their mind in an online class than in a face-to-face class.
    - Students communicate more in an online class than they do in a face-to-face class.
    - Online courses require more time for students to complete successfully than face-to-face courses.
    - Face-to-face classes provided better opportunities for students to interact than online classes.
    - Student and faculty interactions are more effective in face-to-face classes than they are in online classes.
    - More problems occur in online courses than face-to-face courses.
    - More students withdraw from online courses than face-to-face courses.

- Students who procrastinate should not take an online course.
- Technical topics can be effectively taught online.
- Engineering labs cannot be taught online

11. And 12. [Split for ease of display in survey tool.]
    What is your opinion of the effectiveness of the following technologies, tools, or methodologies as used in online engineering courses you have taken or are currently taking:

    1 – Very Effective
    2 – Effective
    3 – Neither Effective nor Ineffective
    4 – Ineffective
    5 – Very Ineffective
    6 - I have no experience with this item. [This response was excluded from statistical calculations.]

    - Streaming of Online Video / Audio of Lectures (Real-Time)
    - Download of Online Video / Audio of Lectures (Recorded)
    - Course Materials Available Online (Blackboard, Moodle, faculty website, etc.)
    - Course Specific Website
    - Online Examinations
    - Discussion Boards
    - Text Chat
    - Audio / Video Chat
    - Online Technical / Analysis Software (Modeling, Simulation, Analysis)
    - Download or Stand-Alone Technical/Analysis Software (Modeling, Simulation, Analysis)
    - Virtual or Remote Labs
    - Online Simulations
    - Blogs
    - Social Networking (Facebook, Ning, Grouply, etc.)
    - Virtual Worlds (Second Life, Active Worlds, etc.)

Appendix B

Interview Questions

1. Demographic questions –
    a. What classes taught/taken online; how many courses / years; department; engineering discipline.
    b. Brief description of experience / history with online courses

2. In your opinion, what are Advantages / Disadvantages of Online Instruction in Engineering?

Results from study (these are questions derived from preliminary survey research):

3. Students and Faculty seem to agree that online courses are not easier than face-to-face courses. Do you agree or disagree and why?
4. Students are more likely than faculty to agree with the following statements. What's your view? Do you agree or disagree and why?
    a. Students are less willing to speak their mind in an online class
    b. Students communicate less in an online class
    c. Online courses require more time for students to complete successfully
5. Faculty and students agree with the followings. What's your view? Do you agree or disagree and why?
    a. Online courses have fewer opportunities for communication
    b. Communication in online courses is less effective
6. Are these differences in communication (less effective, fewer opportunities, etc.) a potential hurdle for continued adoption on online courses?
7. Have any of these hurdles made you consider stopping teaching online / taking online courses? Why?
8. The study shows that both faculty and students feel strongly that technical topics can be effectively taught online. What do you think? Do you agree or disagree and why?
9. Given #8, why do you think adoption of online courses in engineering lags behind other academic areas?
10. Both faculty and students seem to feel that engineering labs cannot be effectively taught online. Do you agree or disagree and why?
11. Optional – could include 1-2 questions about best / worst online tools (Blackboard, online video/audio, course websites / virtual labs, social networking, etc.)
12. In your view, what type of content in engineering can be best delivered online?
13. Can you share any module(s)/component(s) of a course you taught online that you think is effective or not effective? Why?
14. Can you share any good/bad experiences that you have had in taking an online course? What makes it positive/not positive?