# AC 2009-1142: ASSESSING ENGINEERING MANAGEMENT STUDENTS' PERCEPTION OF ON-LINE LEARNING

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# Assessing the Perception of Engineering Management Students towards Online Learning


## Abstract

The purpose of this study is to assess the perception of engineering and engineering management students towards online courses compared to the traditional on-campus courses, and understand their preferences for different online course delivery techniques. Differences between engineering disciplines are also analyzed here along with other factors such as previous exposure to online learning and demographics of the students. Another goal here is to understand whether offering online courses could attract more engineering students to engineering management courses. The results of a survey study conducted among engineering students are presented here to answer these research questions. The results show that there are variations among disciplines and demography, thus an online learning program needs to be designed to address the needs of different types of learners from different engineering disciplines.


## Introduction

*Motivation*:

The interest in online learning has been growing rapidly, since it can provide convenience and flexibility both in terms of location and scheduling. Recently, The University of North Carolina at Charlotte, Systems Engineering and Engineering Management Program, has decided to jump on the online bandwagon. Online delivery has been selected as a strategic initiative, which resulted in the establishment of an Online MS in Engineering Management that will be starting during the Fall of 2009. The presented study was conducted to provide inputs to the design of this new online program.

Distance education seems to be an innovative and educationally progressive idea with many benefits. So no wonder that more and more universities try to be part of this trend. With the advances in technology incorporating Web 2.0 technologies and even virtual reality applications such as Second Life, the possibilities to create great online classes have multiplied. According to the Sloan Consortium (A Consortium of Institutions and Organizations Committed to Quality Online Education) website[9]: "*For the past several years, online enrollments have been growing substantially faster than overall higher education enrollments"* They also give some numbers to prove this statement:

- During Fall 2006, e.g. there were almost 3.5 million students taking at least one online course, which is almost 20% of all US higher education students. This number is almost a 10% increase from the year before.
- The overall growth rate for higher education student population is about 1.5%, while for online enrollments it is 9.7%.

Seeing these numbers gives a definite strong motivation for institutions to join in the online lerning experience.

*Asynchronous, Synchronous or Blended:*

Designing an online program requires selection of adequate development and delivery techniques among many other important considerations. In an online environment the delivery of the class material can be done asynchronously, synchronously or a blend of both. In some cases, the blended approach can combine the asynchronous and synchronous methods with face-to-face interactions as in the traditional sense. An example of asynchronous learning is when the lecture notes/presentation slides, discussion questions, assignments, exams and other materials are posted on the web but no physical meetings take place and interactions are conducted only online, through e-mails, and discussion groups. As an option, the lecture presentations can be prerecorded to include audio or video, which is typically accessible online 24/7. On the other hand, an example of synchronous learning is when online live lectures are scheduled and delivered every week, similar to a traditional class, except that everything takes place through online (both verbal and written) communication, where both the instructor and the students use microphones and headphones for real-time communication. The students listen and view a presentation online but there is no live video of the students and/or the instructor. The lecture is interactive, as in a regular class, where students can ask questions in real time. The session can be recorded for future viewing. The rest of the materials can be posted online as described as in the asynchronous method described above. As an option, a web-camera can also be used to record and stream the instructor giving the lecture online in real-time. An example of a blended learning is when, in addition to the example for asynchronous learning above, in-person office hours/meetings with the instructor are scheduled, or when first and last class sessions meet in person in a classroom setting. For further details on online teaching techniques the reader can refer to e.g. Bender[1].

*Scope:*

This paper tries to answer the following three research questions: 1. what are the students' preferences for different online delivery techniques?; 2. what is the perception of engineering and engineering management students towards online courses compared to the traditional on-campus courses?; 3. Do factors such as previous exposure to online programs, different engineering programs or different demographics affect the outcomes of the survey. In order to address these research questions, a survey has been conducted in the engineering college at the University of North Carolina at Charlotte, and the results of this survey are analyzed and presented here.

The rest of the paper is organized as follows: after presenting a brief literature review about some basic findings and challenges of online learning, the survey study and analysis is presented. Then we share some Online teaching experiences from the MSD Engineering Management Program. The final section summarizes the main findings of our analysis.

**Literature Review**

As the demand increases towards global online programs and courses, many guidelines and papers have been published on how to efficiently create an online learning environment. An important starting point is to have proper infrastructure: as described by Tserenjav[10], the lack of

infrastructure can be challenging in countries such as Mongolia. Based on his study he concluded that even though students there in general seem to be ready for online learning experiences, they would have to use university computer labs for their studies. Some guidelines on how to conduct better online classes are described for example, by Wang[12] as well as how to engage all students in the learning process effectively. They focus on a particular cultural aspect of online learning: whether students' cultural orientation affects their online activities. Attitudes toward online education are examined by Uzunboylu[11], who tried to determine attitudes toward online education of 74 English language teachers in North Cyprus. They found significant differences in attitude toward online education based on teaching experience, school location, and use of e-mail. Another angle of students' attitude towards online learning is studied by McMahon et al.[7] who concluded that access to computers was a key factor in student attitudes toward online education and that computer use and online education are limited to the extent that students lack computer skills. According to Ropp[8], the greater the unfamiliarity with computers, the greater is the student's potential anxiety. Convenience is also a big factor in the attitude toward online learning; students with home computers probably find online education more convenient than students who lack computer access at home. It is also probably true that among working students, time is a main factor determining the attitude towards online learning.

The creation of effective online learning environments is discussed in Durrington et al.[4], who describe how to establish an interactive online learning environment and provide strategies for increasing student interactivity. They highlight the importance of providing a learning environment that is supportive, open, and respectful, responding to student inquiries in a timely manner, and communicating explicitly. They also describe problem-based learning as a strategy for encouraging small group interactivity and problem solving. Caron et al. [2] discusses an effective dynamic online learning environment, which could help professionals in constantly evolving fields such as medicine to keep up as part of their continuing education. Liang, Wang and Hung[6] tried to find similarities in the learning behavior of 60 students and classified them into 3 main categories: Active Participants, Enthusiastic Participants, and Lower Participants. Interestingly, based on the study of these 60 students, they found no difference in the performance among these types.

Dennen et al.[3] summarizes their findings as some "tips" for instructors to adopt best practices: 1. instructors need to reply questions and give feedback in a timely manner; 2. instructors need to show that they are present in the online classrooms on a regular basis; 3. instructors need to communicate their expectations clearly. LaPraire and Hinson[5] present a set of guidelines for establishing the infrastructure needed to develop online learning communities and the types of training and support needed to sustain them.

As the literature review shows above, online learning can be an effective learning approach but needs to be carefully planned and adopted to ensure success. It also requires different strategies, preparations and techniques from traditional classrooms. The study presented here compliments the previous studies as it answers additional related questions about online learning related to the perception of engineering and engineering management students towards online courses compared to the traditional on-campus courses.

**Survey Analysis**

This section describes the survey analysis that was conducted at the College of Engineering at the University of North Carolina at Charlotte during December 2007- February 2008.

The survey is composed of three parts to address the research questions stated earlier:

Part 1: general demographic questions about the participants (questions 1-9),
Part 2: online perception-related questions focusing on different online delivery methods for all engineering students (questions 10-13),
Part 3: online engineering management-related questions for non-engineering management students (questions 15-18).

Next, we are going to describe the main parts of the survey and the corresponding findings.

*Survey Part 1: Survey Demographics*

Participants begin by answering a series of general questions about their gender, age group, race, department, full time/part time student, and level of study. While the Engineering College has approximately 2000 students, 213 students replied the survey (10.5 % response rate). The basic demographics show that 79% of the respondents were male, 21% female, the majority of their age was 20-25 (46%), dominantly white (77%), with the top three majors being mechanical engineering (34%), electrical and computer engineering (28%), civil and environmental engineering (19%). Most of them (86%) are full time students, and mostly undergraduate (83%). The distribution of undergraduates was 31% juniors, 27% freshman, 24% seniors and 19% sophomores. 79% of the respondents indicated that they heard about online learning possibilities before the survey, and 34% of them have completed online classes already.

*Survey Part 2: Perception of all engineering students towards online learning*

In this part, the main online learning questions are stated in Questions 10 and 12 as shown in Tables 1 and 2. Question 10 aims to understand students' interest towards various delivery types for the online lectures using asynchronous, synchronous and blended methods. The respondents give an answer from 1 to 5, 1 being not interested at all and 5 being very interested. Question 12 aims to see how much they prefer online courses compared to the traditional approach, given that the online course content and traditional course content are identical. More specifically, Question 12 asks if the online method would be preferred if the same class was offered online versus the traditional classroom. Similar to Question 10, a five-point scale is used for Question 12, where 5 denotes that it is very likely that the students would enroll to an Online course as opposed to the on-campus course.

| |
|---|
| a. (**Asynchronous**) Lecture notes/presentation slides, discussion questions, assignments, exams and other materials are posted on the web. No physical meetings, interactions take place only online through e-mails, and discussion groups. |
| b. (**Blended**) Office hours/meetings with the instructor in person, per appointment, the rest is online as in Option a. |
| c. (**Blended**) First and last classes meet in person in a classroom setting, the rest is online as in Option a. |
| d. (**Asynchronous**) PowerPoint presentation of the lecture with audio included, accessible online 24/7, the rest of the class settings are the same as in Option a. above. |
| e. (**Synchronous**) Online live lectures scheduled every week similar to a traditional class. Both the instructor and the students use microphones and headphones for real-time communication. The students listen and view a (PowerPoint) presentation online (but no live video of students and/or instructor). The lecture is interactive as in a regular class where students can ask questions in real time. The session can be recorded for future viewing. The rest of the materials are posted online as in Option a. |
| f. (**Synchronous**) Same as Option e., but a web-camera is used to record and stream the instructor giving the lecture online in real-time. |

Table 1. Online Learning options compared in Question 10

| |
|---|
| a. Given that you have the option to take **the same course either Asynchronous Online** (as described in Question 10, Options a. and d.) **or** in a **traditional** physical classroom setting, **how likely is it that you would register in the Asynchronous Online class?** |
| b. Given that you have the option to take **the same course either Blended Online** (as described in Question 10, Options b. and c.) **or** in a **traditional** physical classroom setting, **how likely is it that you would register in the Blended Online class?** |
| c. Given that you have the option to take **the same course either Synchronous Online** (as described in Question 10, Options e. and f.) **or** in a **traditional** physical classroom setting, **how likely is it that you would register in the Synchronous Online class?** |

Table 2. Online Learning options compared in Question 12

*Survey Part 3: Perception of non-engineering management students towards online engineering management classes*

This part of the survey is geared to understand the College of Engineering students' perception towards the Engineering Management Program and to assess whether online learning can increase the student enrollment in Engineering Management Programs. The focus is on the prospective engineering management students, they are asked to fill the rest of the survey only if they are not currently registered in the engineering management program. The main questions in this section are Questions 17 and 18 (Tables 3 and 4). Question 17 investigates how much a student would be inclined to take an engineering management class if it was offered in an online setting. The question also distinguishes between the three different delivery methods offered (a. asynchronous, b. blended, c. synchronous). Question 18 investigates the students' aversion towards online classes in the engineering management program by asking how strongly they feel about not taking an online engineering management class.

| |
|---|
| a. How likely is it that you would **register in an Engineering Management course if it was taught Asynchronous Online** (as described in Question 10, Options a. and d.)? |
| b. How likely is it that you would **register in an Engineering Management course if it was taught Blended Online** (as described in Question 10, Options b. and c.)? |
| c. How likely is it that you would **register in an Engineering Management course if it was taught Synchronous Online** (as described in Question 10, Options e. and f.)? |

Table 3. Online Learning options compared in Question 17

| |
|---|
| a. How likely is it that you would **NOT register in an Engineering Management course if it was taught Asynchronous Online** (as described in Question 10, Options a. and d.)? |
| b. How likely is it that you would **NOT register in an Engineering Management course if it was taught Blended Online** (as described in Question 10, Options b. and c.)? |
| c. How likely is it that you would **NOT register in an Engineering Management course if it was taught Synchronous Online** (as described in Question 10, Options e. and f.)? |

Table 4. Online Learning options compared in Question 18

**Analysis and Results**

Each of the questions above were examined in detail to see if there is a difference between the answers in terms of different demographics such as gender, age groups, full time/part time, graduate vs. undergraduate, undergraduate year of study, different engineering departments and previous exposure to online programs. The main findings are listed below:

As seen in Figure 1, in general, females seem to be more interested in online learning than males, with the exception of the last synchronous method (using real-time web-camera). In this figure the x-axis corresponds to the online delivery options discussed under Question 10 (indicated as Q10 for short). Interestingly, the difference between the genders becomes bigger as we move from undergraduates to graduate students. The most interested in online learning seem to be female graduate students. Although survey questions were not included in the survey about family responsibilities of the students, the authors feel that a possible explanation for this is that female graduate students are trying to balance family and professional life and this seems to give them the biggest flexibility. The answers to Question 12 are similar: female graduate students are the most interested in online learning. This pattern does not change when preference towards online engineering management classes is asked in Question 17 among non-engineering management students: the most interested students in online engineering management classes are still graduate females, regardless of the delivery methods.

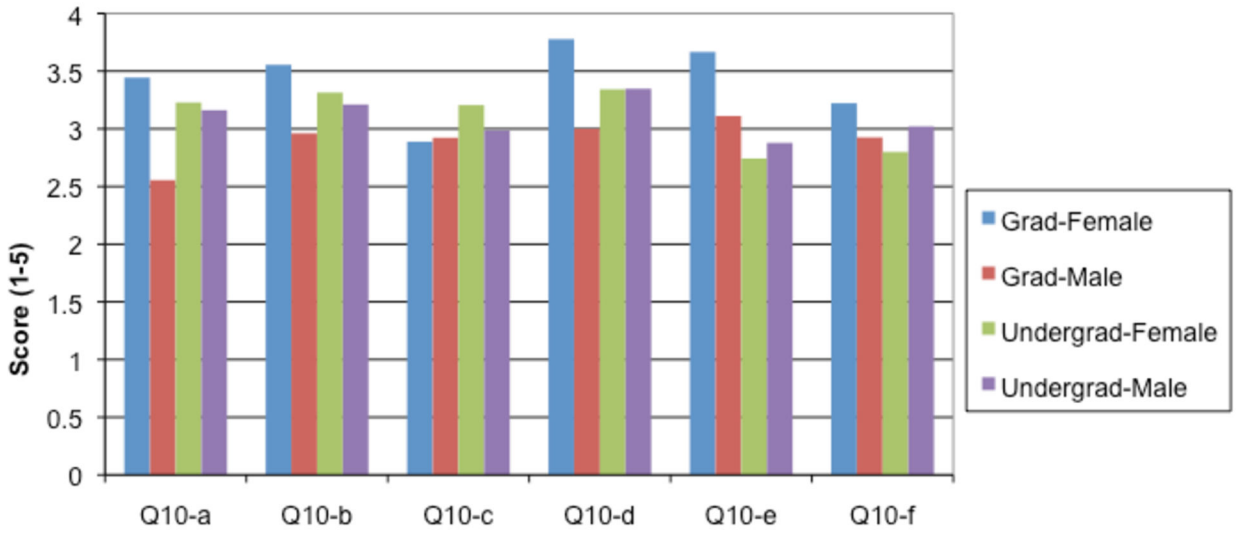


Figure 1. Online Preferences by Gender and Degree Level.

In terms of age groups, there is an age group that is the most interested in online learning: 36-45 (Figure 2). This is the same age group that is by far the most interested in online engineering management classes as well. When we look at the different delivery methods, one pattern stands out: the least interested group for asynchronous and blended learning seems to be the group between 46-55. On the other hand, when answering Question 17, the most interested group in online engineering management classes is still the 36-45 but the least interested group becomes the 46-55 as well as the youngest, <20 age group. While we are not sure about the main reason for this, based on some survey comments it seems that the younger students prefer face-to-face interaction and mentoring, while the older generation is possibly not as internet savvy as some of the younger generations.

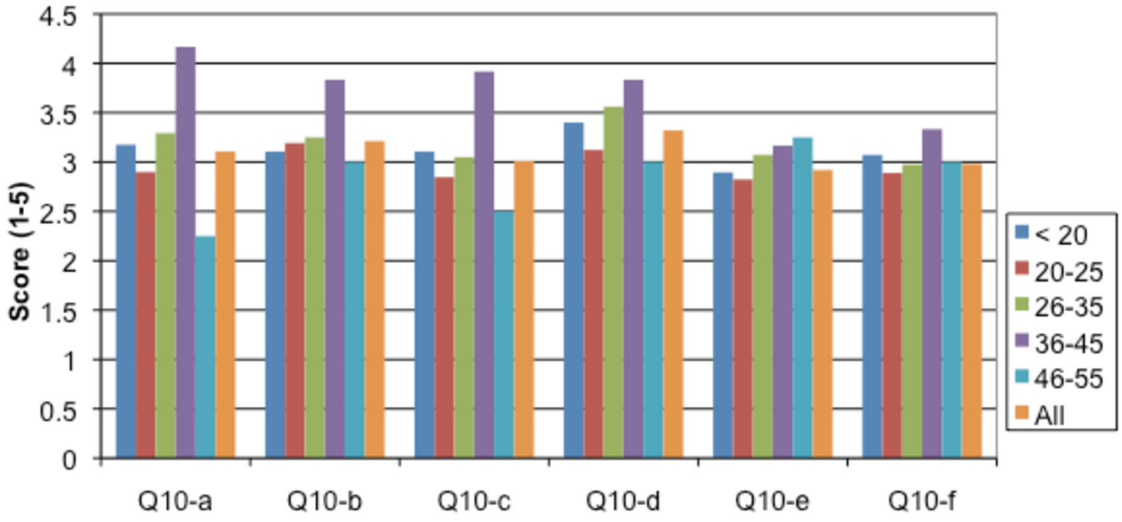


Figure 2. Online Preferences by Age.

As illustrated in Figure 3, the difference between full time vs. part time students is very clear: for each of the questions, part time students have a higher preference towards online learning than full time students. The only exceptions to this rule are Questions 10e and 10 f, about the synchronous delivery methods for graduate students (but not for undergraduates). The results are similar for Question 12: both graduate and undergraduate part time students have a high preference towards online classes. This probably means that part time graduate students are likely to have full time jobs and family, so they really need the flexibility of online learning. But when you take this flexibility away using a synchronous delivery method, they are not interested in it as much as full time students. In terms of the different delivery methods, full time graduate students also have a high preference towards synchronous classes. Part time undergraduate students prefer online learning more than part time graduate students, for all cases. For engineering management classes among non-engineering management students, the most interested are still the part time undergraduate students. This is also confirmed in their answers to Question 18: the aversion towards online engineering management classes is the least among part time undergrads.

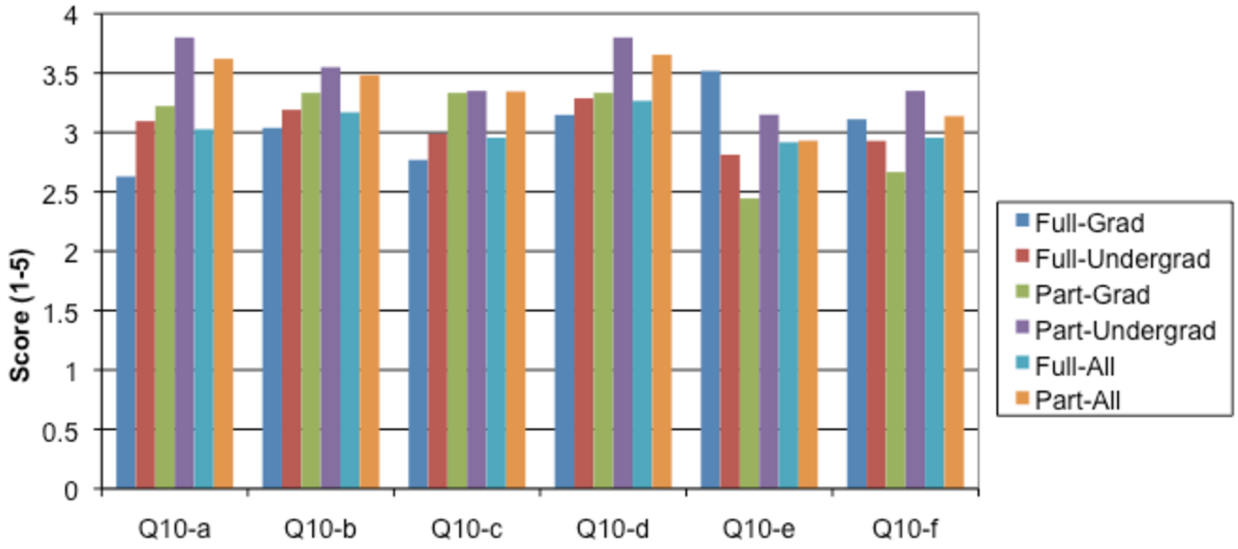


Figure 3. Online Preferences by Full/Part Time Enrollment and Degree Level.

Comparing engineering management and other engineering disciplines, it seems that the least interested graduate students in online learning are the civil engineering students, regardless of the delivery methods (Figure 4). For undergrads (not shown), the least interested students are mechanical engineering students for any delivery method. This is somewhat understandable as a mechanical engineering a student specialized in, say, motorsports wants to have some hands-on experience in the labs as opposed to distance learning. Based on Question 12, as long as it is not synchronous, the highest preference is among engineering technology students for undergrads, while the highest preference is always for engineering management students for graduate students. Interestingly, when their dislike was targeted towards engineering management online classes, there is no noticeable difference between the majors for undergrads. On the other hand, civil engineering students seem to have the biggest dislike towards engineering management online classes.

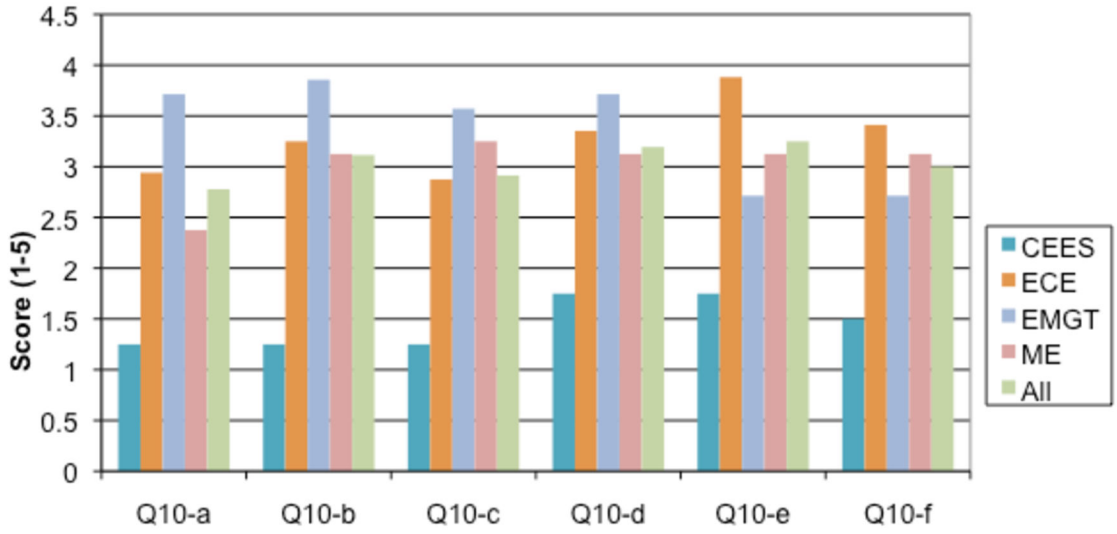


Figure 4. Graduate Student Online Preferences.

Previous exposure to online learning seems to make a difference: those who already have taken online classes before have a higher preference of online classes if it is about asynchronous and blended methods (Figure 5). But those who have not taken online classes before seem to prefer one of the synchronous methods. In most cases, those who already took online classes have a higher likelihood of taking online classes again, regardless of the delivery methods. It seems that having taken already some online classes "proved" for these people that this is a good learning method. Interestingly, when preferences towards engineering management classes were asked among non-engineering management students, the lowest score comes from previously exposed grad students. Question 18, the dislike towards engineering management classes among non-engineering management students seems to support this as well: the highest dislike comes from previously exposed grad students, while there seems to be no noticeable difference between the exposed and non-exposed undergrads.

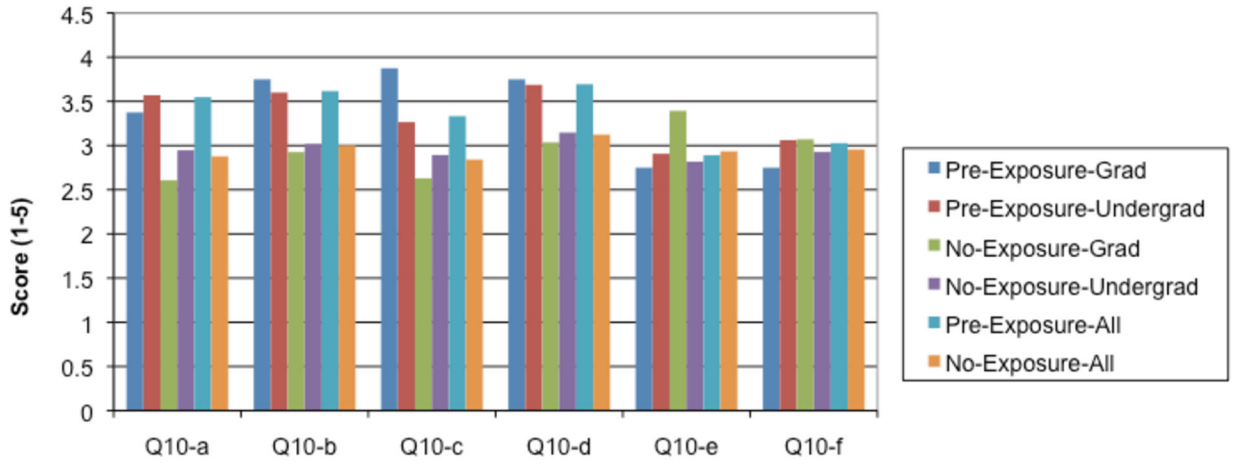


Figure 5. Student Online Preferences based on pre-exposure.

**Early Experiences in the University of North Carolina at Charlotte Engineering Management Program**

The Systems Engineering and Engineering Management Program at the University of North Carolina at Charlotte grants a M.S. Degree in Engineering Management. The program has just started offering a B.S. in Systems Engineering in 2008, which was not there at the time of the survey study. 80% of the MS program's students are working professionals whereas the rest are full time students. It is a relatively small program with about 25-30 graduate students. Online learning has been selected as one of the major strategies to grow the M.S. program. During the Spring of 2008, the M.S. program has piloted two online courses. Based on the findings of the survey presented here, for the pilot implementation of the online courses, the program faculty has decided to adopt a blended online learning approach in which the first and last classes are conducted in class and the rest of the activities to take online. Office hours were flexible either on the phone or in person, by appointment. The first class was used for introductions, to expedite formation teams (for assignments and course project) and to play some manual business simulation games. On the other hand, during the last class the students presented their project work. The courses used Blackboard as the online learning system. The lecture notes were in the form of PowerPoint slides with notes. Every week lectures were posted along with discussion questions that the students were expected to reply. The students were also required to complete homework assignments both individually and in groups. Further blending occurred with traditional classes with the usage of university library's reserves where a set of course related books, DVDs and videotapes were placed for students to learn the materials further. Some of the challenges with the blended learning were mainly related to the scheduling of the first and last classes. We would like to note that the pilot programs received very good student feedback. The feedback was as good in some parts better than the corresponding on-campus courses.

After the pilot, the program has decided to go for a truly online program to increase the reach of the online courses beyond the local community. The survey results presented here have provided important input for the design and justification of the new program that is going to start in the Fall of 2009. It has been decided that the new Online MS in Engineering Management program will be using an asynchronous delivery to eliminate the face-to-face dependencies to the on-campus resources.

**Summary and Conclusions**

A survey study of engineering and engineering management students has been conducted in the engineering college at the University of North Carolina at Charlotte, and the results of this survey are analyzed and presented here. The first goal of the study was to understand the students' preferences for different online delivery techniques, such as asynchronous, synchronous and blended methods. The results show that the students' perception of these methods is such that they tend to have the same opinion towards asynchronous and blended methods. On the other hand, synchronous methods seem to be somewhat less popular, probably because they are not as flexible as asynchronous and blended methods. The second and third goal, to assess the perception of engineering and engineering management students

towards online courses compared to the traditional on-campus courses and to understand whether factors such as previous exposure to online courses, different engineering programs or different demographics affect the outcome.

Some of the main conclusions of the study can be summarized as follows:

- For gender, graduate female students are the most interested in online learning, and particularly in engineering management classes. This result is true regardless of the delivery method.
- For age, the most interested group in both general online learning and engineering management courses is the age group 36-45. The least interested group in online engineering management classes is the age group 46-55.
- Part time students definitely see more value in online learning for any delivery methods for undergraduate students and for asynchronous and blended methods for graduate students.
- According to majors, the least interested graduate students in online learning are civil engineering students, while the least interested undergraduate students are from mechanical engineering.
- The highest interest towards online learning is among undergraduate students in engineering technology, while it is engineering management for graduate students, but these students actually prefer asynchronous and blended methods.
- Among the students who already have taken online classes, the preferred method is asynchronous and blended, but if they have not taken online classes before, they prefer synchronous methods.

The results of this survey can have further implications to engineering programs with similar student enrollment as the sample population presented here. Based on this survey, these results presented above can be used as preliminary guidelines to aid the decision whether an online program should be introduced in a particular program.

While online learning seems to be a pathway to the future, and it seems to be beneficial to the students in many situations, it can also bring new challenges to education as well. Online classes require special infrastructure, student connectivity, and availability of technical support and help desk. The students have to have high motivation and self-discipline to participate in these online classes. Online assessment can be also difficult, and some students might also find it hard because of the lack of personal interaction. It is probably easier to misinterpret things in writing than face-to-face because of the lack of body language and tone of voice. It is also important that all the participants understand and follow the rules of "netiquette". Another possible drawback of online classes is that some students might have a fear of technology, which probably stems from not completely understanding how the material can be efficiently delivered online.

Online education is not without challenges from the educator point of view either. For example, teachers in an online learning environment not only have to understand the material very well but they need to have some technical expertise on the tools available in an online environment. The teacher "toolbox" for efficient teaching needs to be modified for the online environment, which requires extra work for the instructor at the beginning. In addition, on-line learning requires a significant amount of preparation, organization, and additional communication, especially when

a new course is developed, thus brings additional work burden to the instructors. Our focus here, in the current study is on the students' perception on online learning rather than on the instructors' but future research could possibly include the perception of other stakeholders, the faculty point of view as well.

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