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Note From the Editor

Elizabeth A. Cudney

Over the course of 2015, the ASQ Education Division conducted an extensive review of its products and services that will continue in 2016. As part of this analysis, the Education Division leadership team agreed that a transformational change within the division should involve our primary products and services. It is with great pleasure that we announce that the Quality Approaches in Higher Education (QAHE) journal will transition to the Quality Approaches in Education (QAE) journal and will be expanded from a sole focus on higher education to include K-12 and workforce development.

After a very successful ASQ Quality Education Conference and Workshop in November 2015, it was evident that the tools, methods, and approaches applied in K-12, higher education, and workforce development could easily benefit the other areas. Increasing the scope of the journal to these areas will strengthen our ability to solicit solid papers from a wider range of authors. Sharing best practices across multiple segments will be very beneficial to our readers. The change will enable an increase in the number of issues from two to four per year, which will also increase the journal’s visibility and value to the Education Division membership. The main purpose of QAE will be to engage the education community in topics related to improving quality, identifying best practices, and expanding the literature specific to quality in education. Our goal for the journal is to engender conversations that focus on improving educational practices with the use of quality tools throughout the educational experience. I strongly believe that this will be a positive change for QAHE and will continue to provide the same great benefits, but to a wider audience that represents the entire Education Division membership.

As we begin the transition, this issue is comprised of four articles that illustrate the importance of quality in topics that are relevant to all levels of education. The first article by Susan Murray, Amber Henslee, and Douglas Ludlow utilized a survey to compare understanding of plagiarism between first semester and upper-class engineering students. The next article by William Schell, Durwood Sobek, and Maria Velazquez provides a methodology for redesigning engineering curriculum to increase program flexibility and develop more well-rounded engineers while still meeting ABET accreditation requirements. The third article by Michael Schraeder, Mark Jordan, and T.J. Gabriel investigates methods for engaging students prior to the start of class through techniques such as music and trivia. The final article by Susan Murray, Kelly Jones, and Julie Phelps provides a methodology to measure changes in student expectations in graduate-level hybrid courses through the use of pre- and post-surveys. These articles illustrate how quality approaches can be used to measure student understanding, increase curriculum flexibility, improve student engagement, and meet student expectations for learning.
I would also like to take this opportunity to thank Dr. Cindy Veenstra for her dedication and service as an associate editor and special issue editor. Her involvement since the inception of the journal and her passion for improving higher education have been instrumental in the growth of the journal. We greatly appreciate all of your insight, wisdom, and guidance!

Elizabeth Cudney, Ph.D. is an associate professor in the Engineering Management and Systems Engineering Department at Missouri University of Science and Technology. In 2014, Cudney was elected as an ASEM Fellow. In 2013, Cudney was elected as an ASQ Fellow. She was inducted into the ASQ International Academy for Quality in 2010. She received the 2008 ASQ A.V. Feigenbaum Medal and the 2006 SME Outstanding Young Manufacturing Engineering Award. Cudney has published five books and more than 50 journal papers. She holds eight ASQ certifications, which include ASQ Certified Quality Engineer, Manager of Quality/Operational Excellence, and Certified Six Sigma Black Belt, amongst others. Contact her at cudney@mst.edu.
Dear friends of the ASQ Education Division and the Quality Education Conference & Workshop (QECW):

We need your support! The 2016 ASQ QECW is scheduled for November 11-13, 2016, with pre-conference workshops planned for Friday, November 11, and concurrent sessions planned for all day Saturday, November 12, and Sunday morning, November 13, in Houston, TX. Come celebrate World Quality Month with us and help us spread the word on the importance of high quality education! Note that we are partnering with the ASQ Healthcare Division this year to bring an even more exciting program to our attendees than we did last year.

We invite you to submit your session and/or workshop proposals to share your success stories and proven approaches so that others can learn and apply your methodologies and principles upon returning to their educational institutions, industries, businesses, homes, communities, and wherever learning and learning processes are applied. We want to encourage all participants to share their experiences on applying quality tools and the practical application of continuous improvement to sustain a culture of success and create new ways of broadening and enhancing our educational networks.

Proposals may be submitted for 75-minute sessions to be conducted November 12-13 or for four-hour pre-conference workshops on November 11. Please refer to the Call for Proposals and the Proposal Review Process and Proposal Requirements for guidelines for the submission of your proposal. Please let us know if you can't access the links.

We are on a short timeline for our 2016 program. Although our published due date for submission of proposals is March 25, 2016, we anticipate an extension of this date to April 22, 2016. Please watch for the announcement with details.

Submissions must be submitted to Norma Simons (norma@performance-innovation.com) and Belinda Chavez (chavezb1@peoplepc.com).

On behalf of the ASQ QECW Conference Board, we look forward to reviewing your submissions.
Does exposure to higher education writing courses impact engineering students’ understanding of plagiarism?

Evaluating Engineering Students’ Understanding of Plagiarism

Susan L. Murray, Amber M. Henslee, and Douglas K. Ludlow

Abstract

As plagiarism increases among engineering students, there is a debate whether it is committed willfully or unintentionally. In this article we investigate engineering students’ understanding of plagiarism. At Missouri University of Science and Technology (Missouri S&T), 635 first-year engineering students completed a survey/quiz on plagiarism. Only 59% of the freshmen answered correctly when asked about using quotation marks for a direct quote. When questioned about paraphrasing, 52% answered correctly. Recognizing a proper citation was higher with 89% answering correctly. These results suggest shortcomings in first-semester engineering students’ understanding of plagiarism. Students who commit plagiarism may lack knowledge rather than willfully violating ethical behavior. Upper-class engineering students were also surveyed. With regard to recognizing a proper citation, their results were similar to the freshmen; however, they performed worse on proper paraphrasing. Neither prior English or technical communication courses, nor years studying engineering, were key factors in engineering students’ understanding of plagiarism.

Keywords

Higher Education, Plagiarism, Engineering

Introduction

Academic dishonesty is a serious issue. It affects the students who cheat, those who do not cheat, the instructors, and the academic institutions (Macfarlane, Zhang, & Pun, 2014; McCabe, Trevino, & Butterfield, 2001). Self-report rates for college cheating have been documented as high as 80% (Cochran, Chamlin, Wood, & Sellers, 1999). Researchers have studied more than 20 different types of academic dishonesty (Lambert, Hogan, & Barton, 2003) and have found individual factors that are correlated with cheating (Elander, Pittman, Lusher, Fox, & Payne, 2010; McCabe et al., 2001). These factors include age (e.g., younger students cheat more frequently than older students), gender (e.g., males tend to cheat more than females), marital status (e.g., married students tend to cheat less than unmarried students), and grade point average (GPA) (e.g., students with lower GPAs are more likely to cheat) (Newstead, Franklyn-Stokes, & Armstead, 1996; McCabe et al., 2001). Students studying on campus, rather than in distance mode, committed plagiarism at a higher rate. The rate was statistically higher for international students compared to domestic (New Zealand) students (Walker, 2010). Students ages 21-30 were more likely to commit plagiarism than older, non-traditional students. Students in their first year enrolled at Missouri S&T were less likely to plagiarize than those who had been studying at Missouri S&T longer. In a study of more than 500 students’ work, Walker (2010) reported that 23.5% and 12.5% of first-year students plagiarized on the first and second assignment respectively, compared with 28.6% and 15.9% for second-year students, and 33.6% and 30.5% for fourth-year students.

Yet other studies have not found significant differences in individual variables such as gender (McCabe et al., 2001) or GPA (Jordan, 2001). For example, Walker (2010) evaluated over 1,000 writing assignments by more than 500 students to determine the profile of students most likely to commit plagiarism. He found no significant difference between males and females committing violations. Rather than individual factors, contextual
Given the numerous types of academically dishonest behaviors and variables, both individual and contextual, that affect academic behavior, it is not surprising that the literature in this field is broad and the research continues to grow. One specific area of interest is that of plagiarism.

**Plagiarism**

“The word plagiarism is derived from the Latin word plagiarus, meaning someone who kidnaps the child or slave of another” (Weber-Wulff, 2014). One early use of the term was by a poet in response to his work being published under another’s name. He felt his poems were the children of his mind and they had been kidnapped (Weber-Wulff, 2014). While kidnapping may seem to be a strong term, a person committing plagiarism is taking ideas and words created by another.

Plagiarism is different than copyright violations, although there is some overlap. One can copy numerous pages of someone else’s work and properly cite the material; that is not plagiarism. However, the act of using a large amount of material, even while giving credit, can violate the fair use provision of copyright laws. The distinction is that plagiarism involves taking and using without proper credit, while a copyright violation is taking and using beyond fair use. One can plagiarize material that is not under copyright. Often copyright violations are also acts of plagiarism but not necessarily.

Plagiarism can have different forms (Walker, 2010). The most blatant is direct copying; one takes the words of another and uses them without quotation marks or citation. Cut and paste features in word processors have made this easy to do both intentionally or unintentionally (Sutherland-Smith, 2008). Often it takes only a few clicks of the computer mouse and the deed is done. Unintentionally, plagiarism can occur if the secondary author plans to paraphrase the material later but forgets where the material came from and the need to cite it. Another example of unintentional plagiarism is a writer with a mistaken belief that listing the original source in the bibliography or footnote provides adequate credit when quotation marks and a citation are required (Hexham, 2013).

Lofstrom (2011) suggested that explicit misunderstandings among students related to ethics were rare but there may be various underlying beliefs and assumptions related to plagiarism and proper credit. In a follow-up study, Lofstrom and Kupila (2013) found that there were three distinct reasons for plagiarism. The first is intentional, which they define as a deliberate behavior among students who often justify this because other students do it, and the risks of being caught are low. The second reason was contextual plagiarism; when students were overloaded and intentionally plagiarized as a way to cope with being overwhelmed. The final reason presented by Lofstrom and Kupila was unintentional plagiarism caused by a lack of knowledge. Both students and faculty in the study felt unintentional plagiarism was the most common type.

A common form of plagiarism involves paraphrasing an original work. Countless writing instructors have been asked, “How many words do I need to change in a passage for it to no longer be plagiarism?” As engineers, we are accustomed to thinking in numerical terms such as percentages. However, changing a few words in a passage does not make the text or ideas within it belong to someone else. Text that has been paraphrased or edited still needs to be attributed to the original source. Unfortunately, this is an area that is not always clear. Rogi (2001) conducted research investigating the definition of plagiarism among faculty members. There were varying understandings of plagiarism among faculty, even within disciplines. The variation in understanding plagiarism resulted in paraphrasing techniques that were considered acceptable by some faculty and considered plagiarism by others.

Rebecca Moore Howard defined the term “patchwriting.” This type of writing occurs when a student takes sentences, or even phrases, and pastes them together. Howard explains that it is often committed by inexperienced writers who lean too heavily on their sources while writing (Howard, 1999). Patchwriting is a gray area within plagiarism for many. The writer typically does not intentionally steal the work of others, but rather is too dependent due to a lack of familiarity of the material (Weber-Wulff, 2014). This understanding of material is a challenge for educators. We expect our students to learn and summarize technical material, but where is the line among overuse of the original source, proper paraphrasing, and teaching students to synthesize multiple works to gain a richer understanding of the material?

**Frequency of Plagiarism**

It is hard to quantify the rate of plagiarism, although many have suggested it is on the rise. In a recent study, Radunovich, Baugh, and Turner (2009) questioned 542 agricultural and life science students about their knowledge and understanding of plagiarism. The results suggested that there was confusion among students at all levels about plagiarism. This confusion extends to the faculty ranks. With regard to engineering students specifically, Parameswaran and Devi (2006) report “rampant” copying of lab reports.

The National Science Foundation (NSF) states it is imperative that research is carried out following the highest ethical standards. The NSF has seen a rise in research misconduct associated with NSF proposals and awards. The NSF definition of research misconduct encompasses fabrication, falsification, and
plagiarism. In semi-annual reports to Congress, NSF noted several cases of plagiarism, including:

- A faculty member at an Ohio university plagiarized text into four proposals submitted to NSF. He admitted that he copied most of the material, which he said he did because English was not his native language. He also asserted that citations and quotation marks were unnecessary because the text was copied from a public source or was public knowledge. The university investigation concluded that the faculty member's actions were reckless, and he should have known of the need for citation (NSF, 2012a).

- A New Jersey university investigation concluded that an assistant professor knowingly committed plagiarism in 11 unfunded NSF proposals. He plagiarized the majority of the copied text in one proposal from other proposals previously submitted to the same NSF program by other Principal Investigators (PIs), who had posted them online (NSF, 2012a).

- An assistant professor at an Illinois institution plagiarized text into three proposals. The professor acknowledged copying material without citation, but she argued that the text included basic, common information in her field; she acted in “honest error;” she misunderstood the rules of plagiarism as they apply to proposals; and she was under time pressure (NSF, 2012a).

- A Puerto Rico university researcher plagiarized from multiple documents in an NSF proposal. She argued that much of the text she copied did not require attribution because it was found on government web pages. NSF highlighted the difference between information that is common knowledge, which does not require citation, and information that is in the public domain, such as on a government web site, which requires citation (NSF, 2012a).

- An assistant professor at a New York university submitted a proposal to NSF that contained a large amount of material plagiarized from a previously awarded NSF proposal authored by a PI at another university. The professor said that he told the student merely to use the awarded proposal as guidance, and although he said the student did the actual copying, the professor accepted full responsibility. The university concluded that the professor was guilty of reckless plagiarism due to improper oversight of the graduate student and insufficient care with the content of the draft proposal (NSF, 2012a).

Given this confusion about plagiarism, it is possible that students commit plagiarism unintentionally—that is, they are unaware that they have committed an act of academic dishonesty because they do not clearly understand the concept or nuances of plagiarism? Academic dishonesty has implications for future professionalism as well. The engineering profession expects ethical behavior. The National Society of Professional Engineers (NSPE) has a code of ethics (NSPE, 2007). Most, if not all, engineering professional societies have a code of ethics for their members. Ethics is a knowledge area tested on the Fundaments of Engineering (FE) and Professional Engineering (PE) exams. Unethical behavior can result in the loss of one’s engineering license.

As university faculty we seek to better understand our students’ behavior. We surveyed freshmen and upper-class engineering students to determine their understanding of plagiarism. We hoped to gain insight into the question: When our students commit plagiarism, is it a willful act or a lack of understanding the importance and methodology of giving proper intellectual credit?

**Research Methodology**

An online survey modified from Belter and du Pré (2009) was used to test first-year students’ understanding of plagiarism at Missouri S&T. Approximately 1,200 students, in several sections of a first semester, one-credit hour, introduction to engineering course had the option of completing the survey. The survey was one of several assignment choices. Students were not required to participate in this study. However, for those students who chose to participate, they received course credit regardless of their performance on the plagiarism survey. The survey was completed by 635 students. Responses from students who failed to complete the survey fully were eliminated from the analyses.

Demographic questions were included to verify that a representative sample was achieved. The participants were predominately males (77.9%) who identified as Caucasian, non-Hispanic (83.5%). These characteristics are similar to those for the university’s entering freshmen engineering students.

A second group of 129 upper-class engineering students were surveyed to allow a comparison of students’ understanding of plagiarism at different points in their undergraduate education. These surveys were distributed on paper in classes within several different engineering departments on campus. The demographics of the upper-class students were similar to those of the freshmen students. The students were asked how many college-level English or technical communication classes they had taken. Fifty-one percent of sophomores had taken two or more classes. The percentage was 86% for juniors and 76% for seniors. Given previous research (Newstead et al., 1996; McCabe et al., 2001; Walker, 2010), we hypothesized that exposure to higher education writing courses may provide the upper-class students with a stronger understanding of plagiarism compared to entering freshmen.
Survey Questions
The survey included three questions modified from Belter and du Pré (2009), as follows:

To answer items 1-3, refer to the following passage, which is quoted directly from “The Seven Habits of Highly Effective People,” by Stephen Covey (1989), p. 293.

“So the next morning, Gordon went to the beach. As he opened the first prescription, he read, ‘Listen carefully.’ He thought the doctor was insane. How could he listen for three hours? But he had agreed to follow the doctor’s orders, so he listened. He heard the usual sounds of the sea and the birds. After a while, he could hear the other sounds that weren’t so apparent at first. As he listened he began to think of lessons the sea had taught him as a child—patience, respect, an awareness of the interdependence of things. He began to listen to the sounds—and the silence—and to feel a growing peace.”

Question 1: Is it plagiarism if the following sentence appears in your paper?
He heard the usual sounds of the sea and the birds. After a while, he could hear the other sounds that weren’t so apparent at first (Covey, 1989, p. 293).
A) Yes, this is plagiarism. The author’s exact words are not in quotation marks.
B) No, this is not plagiarism. The author’s exact words are properly cited.
C) I don’t know.

This question tested the need for quotation marks. The passage was taken verbatim from the original text. While a citation is given, the necessary quotation marks are not. The correct answer is A.

Question 2: Is it plagiarism if the following sentence appears in your paper?
He heard the typical noises of the sea and the bird life. In a while, he heard other sounds that weren’t so obvious at first (Covey, 1989, p. 293).
A) Yes, this is plagiarism. The author’s exact words are not in quotation marks.
B) No, this is not plagiarism. Enough words were changed to make it my own work.
C) I don’t know.

The passage in this question has minor changes in the wording from the original text. “Usual” was changed to “typical.” “The birds” was changed to “the bird life.” “After a while” was changed to “In a while” and “apparent” was changed to “obvious.” The correct answer is A.

Question 3: Is it plagiarism if the following sentence appears in your paper?
“As he listened he began to think of lessons the sea had taught him as a child—patience, respect, an awareness of the interdependence of things” (Covey, 1989, p. 293).
A) Yes, this is plagiarism. It’s not OK to use a direct quote and cite it properly.
B) No, this is not plagiarism. Quotation marks are used and it is cited properly.
C) I don’t know.

This question includes a quote that is properly cited. The correct answer is B.

Additionally, we assessed students’ knowledge of the institution’s penalty for academic misconduct and the importance of academic integrity using another question modified from Belter and du Pré (2009).

Question 4: What is the penalty for plagiarism?
A) A failing grade for the assignment, possible a failing grade for the course, and even suspension/expulsion.
B) Not much. Maybe just a few points off for the assignment.
C) I don’t know.

The correct answer is A.

Table 1 provides a comparison of the percentage of students who correctly answered the four questions. The more experienced students did recognize the need for quotation marks when using a direct quote at a higher rate than the freshmen (question 1). The

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Freshmen (n = 635)</th>
<th>Sophomores (n = 31)</th>
<th>Juniors (n = 21)</th>
<th>Seniors (n = 77)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand use of quotation marks for a direct quote</td>
<td>59%</td>
<td>77%</td>
<td>81%</td>
<td>71%</td>
</tr>
<tr>
<td>Understand appropriate paraphrasing</td>
<td>52%</td>
<td>39%</td>
<td>43%</td>
<td>30%</td>
</tr>
<tr>
<td>Recognize a proper citation</td>
<td>89%</td>
<td>84%</td>
<td>86%</td>
<td>92%</td>
</tr>
<tr>
<td>Know the penalty for plagiarism</td>
<td>95%</td>
<td>81%</td>
<td>100%</td>
<td>88%</td>
</tr>
</tbody>
</table>
percent of participants who correctly answered the paraphrasing question dropped from 52% for freshmen to only 30% for seniors. Apparently, proper paraphrasing is not clear cut for students. There are no exact rules for how much should be changed to avoid plagiarism, yet it is striking how the percent correct dropped within the samples. Approximately 15% of the students surveyed answered, “I don’t know” to this question. Students recognized a properly cited quotation and understood the penalty for plagiarism at all levels. These data suggest that students within this sample know how to cite a quote and that plagiarism is a significant offense.

**How Common Is Plagiarism?**

The survey also asked the students’ perception of the occurrence of plagiarism on a scale from 0-7 (0 = not common, never happens to 7 = extremely common, everyone plagiarizes). The results are shown in Figure 1. Freshmen were not asked this question. Having only been on campus a few weeks, they did not have a basis to answer this question as accurately as upper-class students. The upper-class students rated plagiarism as a “common” occurrence as follows: 17% of seniors, 18% of juniors, and 8% of sophomores.

**Students’ Ethical Self-Perception**

The survey asked students to rate their own level of perceived ethical behavior using an 8-point Likert scale (0 = not at all, 7 = extremely). The results are shown in Figure 2. The students tended to rate themselves above average on ethics. Ariely (2012) has written extensively about honesty and self-perception. He found that most people like to think of themselves as honest. If given an opportunity to cheat, many will behave dishonestly enough to profit a moderate amount, yet still consider themselves to be honest. In a series of experiments, Ariely found students over report their performance on quizzes, took items that did not belong to them, and padded their expense reports in the range of 10-20%, enough to gain some benefit, yet still consider themselves honest.

**Recommendations**

A variety of methods to teach both what plagiarism is and why it is an important issue have been developed. Elander, Pittam, Lusher, Fox, and Payne (2010) proposed that students lack authorial identity or “the sense a writer has of themselves as an author and the textual identity they construct in their writing” (p. 159). An intervention designed to improve students’ authorial identity resulted in significantly increasing the understanding of authorship and knowledge about plagiarism, and the intervention’s effect was greatest among first-year students (Elander et al., 2010). Jackson (2006) assessed undergraduate computer science majors’ understanding of plagiarism and evaluated the use of an interactive, online tool to improve students’ knowledge. She found students struggle with the concept of plagiarism, specifically paraphrasing. However, the implementation of an online tutorial resulted in, on average, a 6% improvement in distinguishing paraphrasing from plagiarism.

In addition to Jackson’s (2006) web-based tutorial, Belter and du Pré (2009) also developed an online plagiarism instruction tutorial. Rates of plagiarism among psychology students who completed this online tutorial were 6.5% (compared to 25.8% among students who did not complete the tutorial). In an extension of this research, Henslee, Goldsmith, Stone, and Krueger (2015) compared a generic, pre-recorded lecture to a more
specific, online tutorial regarding plagiarism. Results indicated no significant differences between groups with regard to incidents of plagiarism among psychology students. These results suggest that the online tutorial may be an equally effective instructional method compared to a pre-recorded lecture.

A variety of potential solutions exist that warrant further review. Software programs such as EndNote can provide a tool to assist students in managing their references. During the writing process, a few simple clicks allow the writer to add a reference citation to the text and a properly formatted reference at the end of the paper. This type of tool should reduce the “accidental” plagiarism of writers using material and later forgetting where the material came from or the need to give credit.

Other types of software aimed at plagiarism detection include Turnitin and iThenticate. Turnitin allows educators to submit student work and then provides reports identifying original and unoriginal content. Programs such as iThenticate compare a document to content available on the Internet. The software provides a measure of originality and cautions of potential plagiarism issues to the writer or the instructor. Use of such software is becoming more common among engineering journals. Jocoy and DiBiase (2006) found plagiarism among 13% of adult learners in an online course when utilizing detection software. For the same assignments, only 3% were found to have plagiarism when the work was reviewed manually. In a study across multiple disciplines at three universities, Gilmore, Strickland, Timmerman, Maher, and Feldon (2010) found plagiarism to range from 36.3% to 42.6% when student proposals were evaluated using plagiarism detection software. While useful tools, these types of software are only a part of the solution to the ongoing problem of plagiarism.

Another approach used by some universities to reduce plagiarism is educational websites. University of California, Davis has a website geared to students; it educates them on what plagiarism is and how to avoid it as a part of their academic integrity project. Long Island University also has online resources for students. Additionally, Purdue University has a well-respected writing research website, known as the Online Writing Lab (OWL) that does more than warn students about plagiarism. The OWL site includes content on proper citation formats and plagiarism; it also describes how to paraphrase and has a focus on how to improve writing.

Some educators have focused on teaching the proper method of paraphrasing. Eckel (2010) recommends working with students to develop the skill of synthesizing reference materials rather than punishing plagiarism or pushing honor codes. Eckel states that engineering and science students need to understand the differences among quoting, patchwriting, paraphrasing, and synthesis to become better writers and better professionals. We agree with Eckel that, ideally, engineering students should learn how to conceptualize and synthesize multi-dimensional issues. This higher-level thinking skill is not only important during formal education, but for continued professional development as well. However, this does not necessarily negate the benefit of an honor code. Jordan (2001) reported that 40% of students believed that signing an honor code decreased academic dishonesty. Perhaps instilling allegiance among students to such a code is akin to the professional engineer’s allegiance to the NSPE Code of Ethics. That is, instilling respect for ethical behaviors among students should be encompassed as part of comprehensive efforts to teach proper citation, paraphrasing, etc.

Conclusions

Academic integrity, including plagiarism, is an important concern in any academic setting (Macfarlane et al., 2014; McCabe et al., 2001); therefore, efforts to teach students about plagiarism adequately and how to avoid it are imperative. Consistent with previous research, our results indicate that there is not a clear understanding of plagiarism, specifically paraphrasing, among entering freshmen engineering students at our university. Also consistent with other studies (Newstead et al., 1996; McCabe et al., 2001; Walker, 2010), an understanding of plagiarism did not improve as the students took college-level writing and/or technical communication classes or were upper-level engineering students.

This study is just the initial step at our university to research and address academic dishonesty among engineering students. It provides support for the belief that some engineering undergraduate students may be committing plagiarism due to a lack of knowledge about proper citations and paraphrasing rather than a willful lack of academic integrity. The results suggest the need for targeted education aimed at incoming freshmen to clarify what is plagiarism and how to avoid committing it.

References:


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Amber M. Henslee, Ph.D. is an assistant professor in the Psychological Science Department at Missouri University of Science and Technology. Henslee’s clinical specialties are in the areas of addictions and trauma. Her research interests include college student health-related behaviors and the scholarship of teaching and learning. She can be reached at Hensleea@mst.edu.

Douglas K. Ludlow, Ph.D. is a professor in the Chemical & Biochemical Engineering Department at Missouri University of Science and Technology and director of the Freshman Engineering Program. Ludlow’s research interests center on the characterization of surfaces of adsorbents and catalysts. His teaching interests include chemical reactor design and chemical process safety and recently the first-year experience for incoming engineering students. He can be reached at dludlow@mst.edu.
Educating Tomorrow’s Engineer: Adding Flexibility Through Student-Defined Electives
William J. Schell, Durward K. Sobek II, and Maria A. Velazquez

Abstract
Industry and political leaders continue to call for change in the way that engineers are educated. Future engineers need to be more than just technically competent. They must be able to refresh their skills continually to remain relevant in an ever-changing world while simultaneously being able to work effectively with diverse groups of people from a wide variety of backgrounds and expertise. This article examines the process utilized at Montana State University to redesign the curriculum of an industrial engineering program to be more attractive to prospective students while adding the flexibility needed to develop more well-rounded engineers. The project resulted in major curriculum change, with changes to nearly 30% of program credits. The cornerstone of these updates increased program flexibility through a student-defined elective program. Results are discussed including student enrollments, ABET accreditation, and student use of the new flexibility.

Keywords
Higher Education, Accreditation, Student Satisfaction, STEM, 21st Century Skills

Introduction
Consistent calls for additional science, technology, engineering, and math (STEM) graduates in the United States over the past decade have led to an increasing demand for engineering education and climbing enrollments for many existing engineering programs (The White House, 2014; Yoder, 2014). This increased demand has also motivated the creation of many new engineering programs (Meixell, Buyurgan, & Kiassat, 2015; Muggli & Tande, 2011). With these changes in the marketplace, ensuring that a program is ABET accredited is one of the most effective ways for students (consumers) to ensure that the program they are investigating is of sufficient quality that its graduates are ready to enter the workplace in an engineering role (ABET, 2015).

Simultaneous to these rising enrollments, there is a growing call for changing the ways that engineers are educated (American Society for Engineering Education, 2013; National Academy of Engineering, 2013). There is an increasing movement toward the incorporation of curricular materials that promote developing engineers who meet the broad needs of today’s industry for a number of reasons. This includes changes in engineering accreditation criteria (ABET, 2012), calls from seminal reports such as the Engineer of 2020 (National Research Council, 2004), and evidence from engineering graduates that indicate professional skills are often what engineers find most important in the workplace (Passow, 2012). These needs include engineers who are not only technically competent, but also what Atman (2009) defines as well-rounded. In this context, the well-rounded engineer is both broadly educated and holds the skills of a lifelong learner necessary to be prepared for the continuous changes expected in the profession. Unfortunately, the evidence continues to indicate that the engineering professorate is not doing enough to change the way engineers are educated and adequately respond to these changing societal needs (Atman, 2009; National Research Council, 2005; National Science Board, 2007).

In response to these needs, the faculty of an industrial engineering (IE) program at Montana State University (MSU) undertook a multi-year effort to revise the curriculum.
A key desired outcome of the new curriculum was to create program flexibility that enabled students to study additional areas and graduate more well-rounded engineers, while maintaining the program’s ABET accreditation. This flexibility was largely accomplished through the creation of a unique elective system within the curriculum. This article examines the path to the development of this system, how ABET and other key stakeholders view the revised curriculum, how the revised curriculum has performed on key metrics, and how students are putting the flexibility to use.

Curricular Reform in the Literature

Given the broad pressures to improve engineering education, it is not surprising that a number of engineering programs have studied ways to improve their curriculum over the past decade. Often these efforts look to bring in new topics to existing curriculum such as green engineering (Christ et al., 2015), sustainability (Price & Robinson, 2015), innovation and entrepreneurship (Oswald Beiler, 2015), and Total Quality Management (Chowdhury, 2014). In addition to these specific topic efforts, programs have also implemented more wide-reaching changes to better attract and retain diverse students (Busch-Vishniac et al., 2011), modernize their curriculum (Hamidreza et al., 2007), and respond to the needs of external stakeholders (Sari, 2013).

A great deal of the literature regarding IE programs focuses on developing an appropriate topic list, or body of knowledge, to include in the curriculum (Elsayed, 1999; Hamidreza, et al. 2007; Kuo & Deuermeyer, 1998; Sari, 2013). This focus seems to be largely due to the breadth of the discipline and corresponding needs to balance the depth of education in any one area versus covering all of the potential topics that could be considered core (Elsayed, 1999). In what appears to be the most complete work in this area, Hamidreza et al., (2007) performed a three-round Delphi study involving both faculty and industry professionals to define the desired characteristics of an IE with an undergraduate degree. Their work involved several hundred survey respondents and developed a prioritized list of 17 desired characteristics and 45 emerging skills. The researchers then utilized these lists to define priorities for curricular changes in their program.

Context and Motivation for Curricular Reform at Montana State

The effort to add flexibility to the existing curriculum was part of a larger effort to perform a substantive curricular reform. The project resulted in a large-scale change to the curriculum as it had existed for more than a decade. The impetus for this change was created by a variety of internal and external influences on the program that materialized simultaneously. These influences can be categorized using Lattuca and Stark’s (2009) three origins of academic change:

1. Response to external societal pressures.
2. Response to internal pressures from within a program, college, or university.
3. Utilization of new educational ideas.

In this case, new educational ideas fall into two categories. The first are those coming from external societal pressure, while the second are new technologies and techniques implemented in support of classroom instruction. Since this article examines program-level changes, only the first category of new educational ideas are discussed. How these influences affected the program at MSU are summarized in Figure 1.
as integrated design or Lean Six Sigma, are today’s sustainable design and big data analytics. To prepare graduates for successful careers and ensure the continued competitiveness of our nation, engineering curriculum must provide students “a knowledge of contemporary issues” and “an ability to engage in life-long learning” (ABET, 2012). Despite this importance, evidence shows that the engineering professorate is slow to adopt new content and that engineering curriculum remains rather rigid. As noted by participants at a 2013 National Academy of Engineering Forum, “If curricula was redesigned around the needs of the students, rather than the needs of faculty members, they would look quite different” (National Academy of Engineering, 2013).

These changes and pressures point to the need for education to develop a different engineer for the future than the one who is trained for today. But how should the future engineer be different? While opinions vary, a common theme is evident in many reports: the engineer of the future needs to be well-rounded and should be educated accordingly (National Academy of Engineering, 2013; National Research Council, 2005). Well-rounded engineers are more than just technically competent, they must also grasp the bigger-picture needs of their organizations. They must understand what is possible and what is useful. They must then possess the skills needed to effectively communicate the difference to a variety of audiences. How education should be changed to develop a well-rounded engineer has been interpreted in a number of venues. While these recommendations vary, they can be summarized to say that an effective curriculum to educate the engineer of the future should be:

• A broad education (Duderstadt, 2008; National Research Council, 2005; National Science Board, 2007).

• “Well grounded in the basics of mathematics and science, [with an expanded view that includes] the humanities, social science, and economics” (National Research Council, 2004).

• Flexible to promote life-long learning (Duderstadt, 2008), with the end goal that graduates will be better prepared for a constantly changing global economy (National Research Council, 2005).

Internal Pressures for Curricular Reform

In addition to the societal pressure to change the way tomorrow’s engineers are educated, the IE program was under a variety of pressures internal to the program, department, and university. Influences from inside the program included prior work to familiarize all members of the faculty with all courses, substantial changes in the makeup of the faculty, and declining student enrollments. Influences from the department and college included enrollment increases in other programs, which created resource pressures on the IE program and a department-head mandate to reduce the costs of part-time, non-tenurable instructors before being permitted to fill an open tenurable IE position. At the university level, there were also expectations related to the ongoing viability of smaller degree programs, which put additional pressure on the IE program as the smallest in the college.

Together, these internal pressures created a mandate for the curriculum update to improve both the educational efficiency and attractiveness of the curriculum. At the same time, the external environment provided motivation to use the curriculum review to find ways to introduce additional flexibility to support the development of well-rounded engineers, while maintaining ABET accreditation.

The Process of Curricular Reform at Montana State

With these influences in mind, as the faculty began the process to update the curriculum, the team agreed on a fundamental goal of the effort: The goal of the undergraduate Industrial Engineering curriculum rebuild effort is to develop a supremely marketable and compelling degree program that prepares students to make significant contributions to the economic well-being of their employers and to pursue graduate studies at institutions of their choosing.

Based on the overall goal and the needs of internal and external stakeholders, the team agreed on a number of key objectives that should be met with the final curriculum, chief among these were:

1. To maintain ABET accreditation.
2. To ensure an integrated and coherent, yet flexible structure.
3. To maintain strong foundations in engineering and IE fundamentals.
4. To introduce emerging topics deemed important by employers, along with flexibility to add/change topics as market demands shift.

Before detailing the process the team utilized to modify the curriculum in line with this goal and objectives, it is important to discuss the constraints on the development of the new curriculum.

Constraints on Curricular Reform

Any effort to modify an existing curriculum is constrained by a number of factors. In this case study, these factors included compliance with state and university policies, the need for
existing students to complete their degree requirements successfully during the transition with limited or no impact on faculty workloads, and the need to maintain ABET accreditation. Together these form a complex set of interlocking constraints that require systems-thinking approaches be applied to quality improvement in higher education (Furst-Bowe, 2011).

Perhaps the most challenging of these constraints dealt with the inherent conflict regarding credit requirements between state and university policies and ABET requirements. Per Criterion 5 (ABET, 2012), to achieve or maintain accreditation, an engineering program must include:

- 32 semester hours of a combination of college-level math and basic sciences,
- 48 semester hours of engineering topics including engineering sciences and design, and
- a general education component that complements the technical content of the curriculum.

Through these requirements, ABET prescribes the type of curricular content for 80 semester hours, plus the general education requirement. This general education requirement is also prescribed at MSU in the form of Core 2.0 (Montana State University, 2015). Core 2.0 requires that students take at least one course in each of ten different areas including diversity, contemporary issues in science, arts, and others, representing an additional 30 semester hours of courses. This total of 110 prescribed credits leaves little room for additional flexibility before a program of study runs into conflict with the Montana Board of Regents policy, which limits programs to a maximum of 120 semester credits (Montana State University, 1999). Even with the exception granted to engineering programs at MSU allowing a maximum of 128 semester credit hours, without combining multiple objectives into a single course, only 18 credit hours remain to meet both program-specific goals and implement flexibility of topics.

### Modifying the Curriculum

With these constraints guiding the types of options that could be considered, the team engaged in a multi-step process to identify and finalize potential changes to the curriculum and then have those changes approved and implemented. Figure 2 presents an overview of this process.

A year before the formal project to update the curriculum began, the faculty started work to prepare for the project. This work involved a series of faculty meetings to review all courses in the current curriculum. This provided a knowledge base for all faculty in the program, similar to the update efforts of Busch-Vishniac et al. (2011). The formal project began with brainstorming to identify knowledge areas that should be included in the future IE program. The structure sought to elicit faculty knowledge gained from the literature, published reports, student and other stakeholder input, time in industry, and knowledge of other programs. This information was then utilized to identify key subjects central to an IE curriculum, subjects from outside IE which should be included in an IE curriculum, key professional skills that need to be developed through the curriculum, and existing subjects that might not be essential to the curriculum of the future. This resulted in a list of topics to potentially eliminate from the program and an even longer list for possible inclusion that would be helpful in developing graduates who will be successful in their chosen careers. The key areas from outside the discipline identified through this process were:

- organizational psychology and human motivation,
- financial analysis and accounting from a business perspective,
- sales and marketing fundamentals, and
- data-mining skills, including programming and database applications.

While the team was in strong agreement that these topics would be valuable within the curriculum, the process of how to

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**Figure 2: Overview of the Curricular Review Process**
incorporate them into an already full program of study presented a large challenge. The prospect of beginning with a white sheet of paper and building an ideal curriculum from the ground up was considered neither efficient nor practical. This was due to a variety of reasons, including constraints associated with existing university courses outside the influence of the IE faculty, the need for existing IE courses to continue to support other majors within the college, and the need to accommodate existing IE students as the curriculum transitioned into its final state. As an initial step to create space for new topics, while considering the practical issues of implementation, all courses in the existing curriculum were reviewed to consider which might be removed or modified. This step created an initial list of potential changes for consideration, including several courses for potential removal or substantial revision.

This list was then reviewed against the existing curriculum considering ABET credit-hour requirements. These requirements, along with Objective 1 (maintain accreditation) of the process proved a substantial constraint on any potential changes. These constraints were reinforced by the team’s desire to maintain a strong emphasis in IE fundamentals (Objective 3).

To understand the impacts of any proposed change on Objective 3, the team used existing bodies of knowledge, published guidance on the future direction of the profession, and personal knowledge to create a list of core knowledge areas thought to be crucial for future engineering graduates and which should be represented in the degree. These included:

- Systems modelling and optimization techniques
- Management systems
- Engineering economic analysis
- Sustainable system design and analysis
- Human factors
- Quality assurance

The faculty then reviewed course content and mapped the curriculum to this list. These efforts enabled the team to identify areas of perceived strength and deficiencies using a quality scoring matrix approach (Sower, 2011). The perceived deficiencies in the required course work were in two areas: management systems and human factors. These topics combined with the objectives of the reform provided the final framework to evaluate each potential change to the curriculum considered by the team and enabled the final curriculum to take shape. Figure 3 shows an evaluation matrix with examples of the changes considered and the expected impact on the evaluation criteria. While the team modified the listing of required courses to address the perceived deficiency in human factors and designed a new course to address the gap in management systems (Schell, 2013), it became clear that adding many topics from the list of areas outside the discipline would not be easily accomplished. This led the team to search for other ways to utilize the curriculum to develop more well-rounded engineers. This was done by adding more flexibility to the program through the student-defined electives.

Once the faculty had agreed to a complete draft of a revised curriculum, the process of internal and external review as well as approval and implementation began in earnest. This process included focus group meetings with junior and senior students from the Alpha Pi Mu honor society and members of the department’s Industrial Advisory Board (IAB). These two groups provided the type of counterbalance of student and industry desires that Hall, Swart, & Duncan, (2012) argued is important to utilize to avoid some of the overly customer-centric approaches happening today in higher education. Consistent with published reports of industry direction to curriculum design (Sari, 2013), feedback from the IAB was universally positive. Board members were excited about specific updates to sequences in operations research and human factors as well as the improved coverage of management systems and increased flexibility. The student review also generated almost universally positive feedback. Students were pleased to see the amount of thought that had gone into updating the experience for future IE majors and were excited about the majority of the changes, including the increased flexibility. Subsequent reviews by the college-level curriculum committee, university-level faculty senate review, and the Office of the Provost went smoothly with several members making positive comments regarding the new electives policy and substantial praise from the long-standing chair of the college committee. At the conclusion of the process, nearly 30% of the credits in the curriculum had some change in status, and curriculum delivery became more efficient for the IE faculty with substantial reduction in program-level teaching loads.

Adding Flexibility—Origin of the Cognate

A key aspect of creating flexibility in the curriculum was the development of the cognate elective program. Merriam-Webster defines cognate as “of the same or similar nature, or generically similar” (“Cognate,” n.d.). Thus, the cognate program enables students to select a set of related courses from across the university, and beyond, that supports their interest area and augments their classic IE education. In addition, the cognate is designed to promote more meaningful use of MSU’s Core 2.0 general education requirement, since students often build upon designated core courses as they select courses for their desired cognate.

The cognate program has its origin in the combination of two distinct ideas for curricular improvement. The first was to...
provide students the opportunity to develop a unique area of expertise that would support their chosen career aspirations. Because IE is a very broad field, practitioners can be successful in virtually any industry, from manufacturing to financial services and healthcare to retail. By choosing an appropriate set of courses, students can gain some industry-level expertise in one of these areas and differentiate themselves in the job search process. The second idea was born from the larger view of skills that would be valuable to IE students in their later careers, but there was a challenge of how to fit them into an already full program of study. This challenge was substantively overcome by enabling students to add complementary depth to their education with the cognate.

**Broadening Education With the Cognate**

To ensure that the cognate achieved the desired educational outcomes and is not merely seen by students as a way to find three easy courses to complete their degree, several basic requirements are provided through the published cognate policy (Montana State University Industrial Engineering Program, 2013). These requirements, and their rationale are summarized as follows:

1. **Students will take a minimum of nine (9) credits from outside the required curriculum coursework.** Although many of the faculty would have preferred a greater number of credits, Montana law limits the number of required credits in a degree program.

**Figure 3: Evaluation Matrix With Example Changes Considered**

<table>
<thead>
<tr>
<th>Key Outcomes</th>
<th>Core Topic Areas</th>
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<tbody>
<tr>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Strong positive influence expected</td>
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<td><img src="Symbol.png" alt="Symbol Legend" /> = Slight negative influence expected</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Strong negative influence expected</td>
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<tr>
<th>Replace professional electives with flexible system</th>
<th><img src="Symbol.png" alt="Symbol Legend" /> = Strong positive influence expected</th>
<th><img src="Symbol.png" alt="Symbol Legend" /> = Slight positive influence expected</th>
<th><img src="Symbol.png" alt="Symbol Legend" /> = Slight negative influence expected</th>
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<tr>
<td>Develop new management course</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Strong positive influence expected</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Slight positive influence expected</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Slight negative influence expected</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Strong negative influence expected</td>
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<tr>
<td>Eliminate differential equations requirement</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Strong positive influence expected</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Slight positive influence expected</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Slight negative influence expected</td>
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<tr>
<td>Condense operations research sequence to two semesters</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Strong positive influence expected</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Slight positive influence expected</td>
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<tr>
<td>Move elective human factors courses to required</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Strong positive influence expected</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Slight positive influence expected</td>
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<tr>
<td>Eliminate management focused professional elective courses</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Strong positive influence expected</td>
<td><img src="Symbol.png" alt="Symbol Legend" /> = Slight positive influence expected</td>
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<td><img src="Symbol.png" alt="Symbol Legend" /> = Strong negative influence expected</td>
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</table>
2. Any course that is taken to satisfy required courses or university core requirements for the Bachelor of Science degree in IE cannot be used to meet the cognate requirement. This requirement simply ensures that students do not attempt to double count credits and then fail to meet the credit requirements for the degree.

3. At least six (6) credits must be at the 300-level or above. This requirement ensures that students move beyond superficial topics and obtain some depth in their chosen area.

4. The credits must represent a coherent area of study relevant to some aspect of IE as a discipline or practice. This reflects the very definition of cognate and helps ensure that students achieve depth in the chosen area.

5. Proposed cognates included in a student’s program of study must be approved by the student’s advisor and the IE Program Coordinator. This requirement provides a final check on cognate quality and an early warning system with regard to any unforeseen issues with the program.

The first three of these requirements are straightforward and easily understood by students. However, the fourth requirement of the cognate presents a challenge, since what constitutes a “coherent area of study” can be interpreted in many ways. To support students as they work through what might be a critical area of uncertainty, the faculty took a number of steps to provide additional scaffolding for students. First, in the cognate policy, students are informed that they automatically meet the cognate requirements if they complete a university-approved minor. In addition to providing clarification with regard to what a coherent area of study might look like, this customer-centric approach was expected to address the frustration of those students who had looked to add a minor, only to find that it would require substantial additional time and expense at MSU to complete both the major and desired minor. Students were further informed that they can complete the cognate requirements by selecting a subset of courses from any approved minor, as long as those courses meet the credit and level minimums outlined. Finally, the faculty provided a list of sample, custom-created cognates as examples to help students think through their options. Faculty built these sample cognates using knowledge of contemporary issues gained from industry input and the literature, as well as prior student interest. The examples are shown in Table 1.

Results From Program Implementation

In many ways the results from the curriculum update have met and exceeded the expectations of the faculty members involved in its execution. Given the nature of the multiple objectives of the work, we will examine these results in two distinct discussions. First, we examine the impact of the program on areas outside of increasing curricular flexibility and the ability to educate more well-rounded engineers.

Enrollment Growth, Retention, Student Performance, and ABET Evaluation

In the five years prior to the curriculum review, the IE program at MSU had experienced multiple years of declining enrollments from a high of more than 100 undergraduate majors to only 73 majors, a trend that continued during the redesign effort. While IE shrank nearly 30% during this period, the college experienced a 25% enrollment growth. The redesign of the IE curriculum has had a major positive impact on enrollment numbers. Beginning one year after implementation, IE enrollment grew from less than 70 majors in fall 2012 to nearly 120 in fall 2015, a growth rate that has outpaced the college’s own record enrollments. At the same time, a two-sample t-test of enrollment numbers for the four years prior to and following the change shows the program has

<table>
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<tr>
<th>Healthcare</th>
<th>Design</th>
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<tr>
<td>• CHTH 210 Foundations of Community Health (3 cr.)</td>
<td>• CS 145RA Web Design (3 cr.)</td>
</tr>
<tr>
<td>• HADM 445 Managing Healthcare Orgs (3 cr.)</td>
<td>• EMEC 403 CAE IV-Design Integration (3 cr.)</td>
</tr>
<tr>
<td>• EIND 506 Design of Healthcare Delivery Sys. (3 cr.)</td>
<td>• EMEC 465 Bio-inspired Engineering (3 cr.)</td>
</tr>
<tr>
<td></td>
<td>Take ARCH 121IA to satisfy university core requirement.</td>
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<tr>
<th>Sustainability</th>
<th>Inventory Management</th>
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<tbody>
<tr>
<td>• ECNS 132 Econ &amp; the Environment (3 cr.) or</td>
<td>• BMGT 405 Supply Chain Analytics (3 cr.)</td>
</tr>
<tr>
<td>• ECNS 332 Econ of Natural Resources (3 cr.)</td>
<td>• EIND 373 Prod Inventory Cost Analysis (3 cr.)</td>
</tr>
<tr>
<td>• BMGT 410 Sustainable Business Practices (3 cr.)</td>
<td>• EIND 468 Mgr Forecast &amp; Decision Analysis (3 cr.)</td>
</tr>
<tr>
<td>• SOCI 470 Environmental Sociology (3 cr.)</td>
<td></td>
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<tr>
<td>Take ECNS 101IS or ECNS 251IS to satisfy university core requirement.</td>
<td></td>
</tr>
</tbody>
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Table 1: Faculty-Designed Cognates Provided to Students as Examples

Montana University System Course Codes

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attracted significant \((p = 0.019)\) increases in freshman enrollments. It has also continued to attract meaningful transfers. This performance is evident in freshmen-sophomore retention rates that average 132\% in the past three years and sophomore-junior rates of 110\% during that same period. Student performance remains high with students averaging over a 90\% pass rate on the Fundamentals of Engineering (FE) examination since the curricular changes were implemented, including three of the last four semesters achieving 100\% pass rates. As all students are required to take the FE as part of their degree requirements, this is a meaningful measure of program outcomes. In addition, graduates from the program have enjoyed job or graduate school placement rates of 100\% each of the past five years.

Unlike some other programs that have sought to develop flexibility in an undergraduate engineering program without seeking ABET accreditation (Sticklen & Rosenberg, 2010), maintaining accreditation was a key requirement of this update. This requirement was made more difficult due to the level of change. In addition to modifying nearly 30\% of program credits, the curriculum review resulted in the adoption of a program name that more accurately reflects the updated curricular content and broad applicability of the degree. The new name became Industrial and Management Systems Engineering (IMSE). As expected, this change led to the program being evaluated on both the Industrial Engineering and Management Engineering criteria on its recent ABET evaluation visit. This review went very well. While official results will not be available until summer 2016, the feedback provided by the evaluator was positive and noted the cognate elective policy as both a strength and differentiator.

**How Students Benefit From Educational Flexibility**

One of the reasons that the ABET evaluator noted the cognate as a strength is due to the many beneficial educational outcomes aligned with the student outcome expectations of ABET (ABET, 2012). By pursuing the cognate, students will be enrolled in classes with many students from outside the engineering program. This exposure to students from other disciplines in upper-division courses appears to enhance IE student’s abilities to work in multi-disciplinary environments (outcome d) and communicate effectively (outcome g). Because these interactions will expose them to different perspectives and expertise, the cognate also appears to improve student ability to assess the impact of their work in a larger context (outcome h). Finally, because students must take ownership of the development and execution of their cognate, the system better prepares them to engage in lifelong learning (outcome i). Since 2010, two of these outcomes (g, h) have been evaluated each year by the program’s IAB through review and scoring of capstone project reports written by graduating seniors. On both measures, the average rating has climbed from near 3 prior to the change, to in excess of 3.5 following the change. These measures are on a scale where 3 = achieved and 4 = strongly achieved the outcome being evaluated. In addition, senior exit surveys measuring their perception of how well the program has prepared them to demonstrate each of the standard 11 ABET student outcomes (ABET, 2012) shows each outcome achieving the benchmark measure of 80\% strongly agreeing or agreeing, and the average of all measures increasing since the changes were implemented.

While the cognate provides a number of program-level outcome benefits, only through implementation has it become clear how students are making use of this newfound flexibility and developing a more well-rounded skill set and perspective. To better understand the utilization of this newfound flexibility, a two-part study was completed one year after the implementation of the program and again three years into the implementation. Each year, the first part of the study reviewed the advising files of current students to categorize the cognate plans of any student who already had a documented set of cognate courses in his or her program of study. The second part used an assignment given to new IE students in the first-semester, introductory course. In this assignment the students were given the cognate advising materials and asked to design their own draft cognate to include in their future program of study and explain why the cognate interested them.

One year following the implementation, these efforts provided a list of 50 cognates for review, while the most recent effort provided 74. To better understand how students developed their programs, the cognates were categorized in one of three ways:

- **Example:** The student utilized one of the example cognates provided by the faculty.
- **Minor:** The student designed a cognate that represented a sub-set of a university-approved minor or intends to complete a minor.
- **Custom:** The student designed his or her own custom cognate program.

Table 2 summarizes this data for the each cohort for both of the years the data was collected.

The information presented in Table 2 begins to show the diversity of uses that students are finding for their cognates. In fact, only six of the 51 cognates found in student advising files are from areas that might typically be considered part of the electives offered in a more traditional IE program, such as inventory...
management, supply chain, or human factors. The remaining nearly 90% of cognates are from areas as wide ranging as community health, sociology, foreign languages, and business or entrepreneurship. Of these, by far the most popular are business topics, representing nearly 20% of the data set.

### Table 2: Distribution of Developed Cognates

<table>
<thead>
<tr>
<th></th>
<th>Fall 2013 Data Set</th>
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<th>Fall 2015 Data Set</th>
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<tbody>
<tr>
<td></td>
<td>Students in Intro Course</td>
<td>Experienced IE Students</td>
<td>Total</td>
</tr>
<tr>
<td>Example Minor</td>
<td>12</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Example Custom</td>
<td>8</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
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<tr>
<td></td>
<td>32</td>
<td>18</td>
<td>50</td>
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Perhaps even more informative than the summary data are specific examples of how students are putting their cognate programs to use to achieve their near-term career goals. In one of the first cognates developed, a student who desired to work in healthcare developed a custom healthcare cognate combining a graduate course in healthcare engineering with courses in nursing and public health administration to deepen her understanding of the industry. Following graduation, this student was hired as a project manager and healthcare engineer for a leading medical research hospital in the Midwest. In another case, a recent graduate used study-abroad courses to build a focus in supply chain management since adequate courses did not exist at MSU at that time. This student is now working as a supply chain engineer in the oil and gas exploration industry. This dramatic use of courses from outside MSU is not an isolated case. Additional examples include a junior student currently studying sustainability topics in Sweden as part of his cognate, while another prepares to study in Japan as part of his language cognate, and another is exploring online courses in sports management for a cognate in Sabermetrics. A final example is a student with an interest in improving engineering education, who has developed a cognate around engineering writing research by combining course credit from an undergraduate research experience with advanced technical writing work. These are but a few of many cases where the flexibility provided by the cognate is making a real difference for students. In each of these cases, the cognate program enables students to pursue their passion while broadening their educational experiences.

### Conclusion

A variety of external and internal forces created the impetus for transforming the IE curriculum into the IMSE curriculum at MSU. A key consideration of the faculty in this change was how to add flexibility to the curriculum to address calls for developing more well-rounded engineers who are prepared to meet the demands expected of engineers in the future. At the end of the update process, nearly 30% of the credits in the curriculum experienced some change in status, and curriculum delivery became more efficient for the IE faculty with substantial reduction in program-level teaching loads. By modifying the curriculum in key ways, the faculty were able to increase the flexibility of the degree program while maintaining ABET accreditation.

The new curriculum incorporates a nine-semester-hour cognate-elective program that allows students the flexibility to explore additional educational areas and become more well-rounded engineers. During initial implementation, students have used the cognate to study a broad range of areas. Results indicate that the effort has met its fundamental goals on each dimension, including increased enrollments, high student performance in IE fundamentals, and increased student interest in studying a broad range of topics outside IE that will further their career goals. In the spirit of continuous improvement, the faculty continues to monitor the success of these changes and look for additional enhancement opportunities for the curriculum and cognate program.

### Acknowledgments

The authors would like to acknowledge the other IE faculty who also played key roles in the development and execution of the larger curriculum review project—David Claudio, Laura Stanley, and Nicholas Ward—and the support and input of our department head at the time, Christopher Jenkins.

### References:


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Pre-teaching Strategies Contributing to a Positive Learning Environment

Mike Schraeder, Mark H. Jordan, T. J. Gabriel

Abstract

In our knowledge-based society, the ability to learn or enable people to learn is essential. Colleges and universities are viewed as key sources for disseminating knowledge. Literature shows that actions shaping the classroom environment, increasing student interest, and enhancing engagement have positive implications for student learning. This article summarizes our assessment of two different methods used prior to the start of class time by the authors to try to increase readiness to learn, while enlivening students’ attitudes prior to the actual formal teaching and learning session. One author played music in the background before class, and the other authors asked trivia questions. A study was performed to test the benefits of using trivia questions before class to improve student experience in a class where participation is included as part of the course score. The benefits observed from each of these strategies are discussed.

Keywords

Higher Education, Learning Environment, Student Engagement

Introduction

The acquisition and management of information are seen as critically important in the context of the knowledge-based economy that characterizes the current business landscape (Psarras, 2006). The process of acquiring information is embodied, to some extent, within the process of learning. There are a variety of venues and resources available for those interested in engaging in the learning process. College programs, however, are still among the most well-respected sources of formal knowledge acquisition and learning. It is readily acknowledged that college does impact students (Donaldson & Graham, 1999).

The increased importance of “learning” in this knowledge-based economy is accompanied by the need to better understand factors that affect outcomes or quality associated with learning environments (Self & Schraeder, 2007). Business schools, in particular, face intense pressure to demonstrate the effectiveness of their programs to multiple stakeholders. Specifically, external stakeholders, such as businesses and organizations, are interested in the quality of learning that occurs in college programs since the graduates of these programs will ultimately seek employment within these organizations. As such, these graduates collectively comprise a resource that could be a competitive advantage for these organizations. Colleges of business seeking special accreditation (e.g., from organizations such as the Association to Advance Collegiate Schools of Business) also face pressures to monitor, track, and improve the effectiveness of their programs (Trapnell & Boxx, 2011). Mastery or learning facts, theories, and details within specific content domains represent an important element in the overall context of learning in business programs. However, more general types of learning that are not domain or subject specific, such as critical thinking skills, are also viewed as important outcomes associated with a college education (Bissell & Lemons, 2006; Burbach, Matkin, & Fritz, 2004), as well as being considered valuable in the context of work and jobs (McEwen, 1994).

There are obviously a number of factors which contribute to the overall quality of learning that takes place in the classroom. For example, the level of student engagement, which
is regarded as multi-faceted, is recognized as an important factor impacting learning outcomes (Handelsman, Briggs, Sullivan, & Towler, 2005). According to Rachal, Daigle, and Rachal (2007), “student engagement is defined as active participation in the learning process” (p. 191). Further, in a study detailing efforts to develop a measure of student engagement, Handelsman, Briggs, Sullivan, and Towler (2005) identified four salient factors they labeled as emotional engagement, skills engagement, performance engagement, and participation-interaction engagement as components or dimensions of student engagement. Learning is an inherently individual process since each student tends to learn differently than others (Ramsey & Fitzgibbons, 2005). Individual levels of willingness or a readiness to learn is an important determinant influencing how well learning actually takes place, while actively involving learners in the process can also have positive implications (Davidhizar & Bechtel, 2000). Further, learning activities that tap into the emotions and feelings of students could have positive effects on students’ readiness to learn (Ramsey & Fitzgibbons, 2005).

With these points in mind, another important factor that merits special consideration is the overall culture or atmosphere of the classroom. There is evidence that students’ perceptions about the learning environment can impact their motivation to learn (Wooten, 1998). For example, in their study of 671 undergraduate students, Perlman and McCann (1998) reported that students’ primary pet peeves about teaching were the instructors’ intellectual arrogance and talking down to students, a lack of respect for students, and instructors who seem unapproachable. Additionally, Brewer (2008) argues that the atmosphere of the classroom is critically important and that students make an assessment within the first five minutes after entering the classroom about the safety of the environment. He goes on to state that “…students learn best in a state of relaxed alertness but may shut down to learning if the atmosphere is uncomfortable” (p. 52). This is important given Nilson’s (2010) argument regarding the importance of setting expectations from the first day of class. She reasons that what instructors do in the first class will affect students’ expectations and behaviors for the rest of the semester. Likewise, we believe that what instructors do before each class begins can have an enormous impact on expectations and behaviors for that particular class meeting.

The responsibility for creating an effective or positive learning environment ultimately resides with the faculty who are teaching the courses (Farkas, 2012). While college faculty typically complete rigorous coursework during the pursuit of their post-graduate degrees, they generally receive little training or guidance on effective teaching methodologies (Bickford & Van Vleck, 1997). Fortunately, there are numerous tools and techniques faculty can adopt in their quest to facilitate student learning (Leong, 2005).

This article summarizes the use of simple strategies that have been proven useful to the authors in facilitating a positive learning environment in their classrooms. Specifically, the authors have discovered that playing music in the background prior to class and asking trivia questions prior to class can have positive implications on the classroom learning environment. The tone of this article is not intended to be rigorous, but instead, provides an illustration of how the authors have successfully used these strategies.

The Use of Music

Have you ever watched a movie or commercial with the sound muted? If so, you can attest to the power of music. Faculty who have taught for any length of time are likely aware of the awkward silence that is often present in the classroom prior to the start of class sessions. As students become more accustomed to the instructor and their fellow classmates, this silence may be abated by the occasional chatter of students talking amongst themselves. Learning, however, is ideally a dynamic, energy-infused process that actively engages students in the journey of gaining knowledge. Contemplating possible remedies for this awkward silence along with the desire to create a more positive tone in the classroom led one author to identify music as a potential catalyst for change. Thus emerged a quasi-experiment where music was played in the background of the classroom prior to the start of each class. It did not require expertise in music. In fact, Brewer (2008) argues “the ability to recognize key effects of music and to understand how to use them to create a desired environment is all that is necessary for intentional use of music in the classroom” (p. 18).

From the first session with the students in a new semester, music was used in the 10-15 minutes before the start of the class period in an undergraduate business course. Early in the semester, the choice of music reflected either the favorites of the instructor or popular choices of the students from previous semesters. As the semester progressed, the choices tended to move toward music selected by the current students in the class. This allowed the students to have a voice in the class and helped develop a personal connection between the students and the instructor.

The pre-class time music appeared to affect the environment positively. Within a short time, the classroom, now filled with music, was more lively and upbeat. The wide variety of music that was played tapped into different student preferences, eliciting some interesting discussions and revelations about people’s music preferences. Familiar songs also created a sense of frivolity as students would commonly sing along with the lyrics of
well-known tunes. A previously quiet and unengaged group of students at the start of the class session now chattered away and was ready to, at a minimum, mentally engage in the class material.

**Anecdotal Summary of Benefits Associated With Using Music**

In general, the students seemed to respond positively when music was played prior to the start of class. Following are some specific, anecdotal benefits that merit discussion.

**Increased learning:** Whereas no empirical studies were performed by the authors, anecdotal conclusions are consistent with current research that suggests the use of music can have small to large positive results. A breakthrough study published in 1993 found that listening to a specific piece of Mozart’s work over a two-year period improved spatial-temporal reasoning ability (Rauscher, Shaw, & Ky, 1993). Other studies have also shown promise with respect to music and improved retention and recall of information (Mammarella, Fairfield, & Comoldi, 2007), emotional intelligence and creativity (Jensen, 2000), and reading and literacy skills (Register, 2001).

**Potential instructor-student personal connection:** It is not uncommon for previously quiet and reserved students to openly respond to the type of music played. This is a great opportunity to make personal connections with these students. Sharing common interests in music may open the door for communication, allowing the instructor to interact with students in ways that did not previously exist and could show students that the instructor cares. This is valuable to consider given research indicating that professional and personal qualities are valued by students and include wanting students to succeed and genuinely caring about each and every student (Helterbran, 2008).

**Increased social interaction:** The widespread ownership of portable music players is just one source of evidence related to the overall importance of music for individuals. Playing music before class changed the typical atmosphere in the classroom from one of dread that could accompany the thought of listening to another 60-90 minutes of lecture and discussion, to an atmosphere of enthusiasm where many students were interacting by discussing genres of music, bands, concerts, and the like. The challenge, then, for the instructor changes from one of engaging the students from a state of non-involvement to leveraging the energy in ways that facilitate the overall learning experience. Many times the music session was followed by a discussion of what type of music the students prefer, what other artists are in this genre of music, and alternate tastes. This allowed for open discussion that helped the instructor model the type of discussion or interaction that students desired throughout the course.

**Openness to use of music in class activity:** Although not part of the pre-teaching environment, music can also be used in class activities to meet educational objectives. The importance of playing music before class is reflected, to some extent, in the possibility that the students will associate music with a learning environment. Music can then be used to help meet an educational objective, such as using music lyrics as a way to identify strengths and weaknesses in a self-awareness assignment or activity (Hartman & Conklin, 2009).

**The Use of Trivia Questions**

To create a better overall learning experience for students, two authors of this article endeavored to build course lectures around active and participatory learning practices that would not only expose students to requisite course concepts, but would also actively engage students in the learning process. Quite often, however, the level of student engagement or participation in these activities fell short of expectations. During early portions of course lectures, students tended to exhibit a general reluctance to participate in discussions or extension activities. However, as the lectures progressed, participation and engagement seemed to emerge. In an effort to get students more active earlier in lectures, two of the authors started the practice of asking trivia questions prior to the beginning of each class. This exercise typically involved asking students five to 10 trivia questions that usually had nothing to do with the business courses being taught or the content to be covered. The purpose in asking trivia questions that were not related to the course was to avoid creating any sense of perceived pressure to get the “right” answer. As such, this may have been viewed as a low-stakes exercise by the students wherein there were no material consequences for guessing or giving the wrong answer. The scope of questions ranged from mundane facts to utterly useless information. For example, one question might ask, what is a group of frogs called? (Answer: an army) The questions were typically obtained through a variety of resources readily available on the Internet. To generate possible trivia questions, the authors simply used search terms such as interesting trivia questions or fun trivia questions. During holiday seasons, some questions were chosen that were specific to the holiday. For example, during the Christmas season, the author would ask questions such as, what is the most popular Christmas carol? or on average, how many Christmas cards does an individual typically send each year?

Using trivia questions prior to the start of each class encouraged early student interaction. In his book on creative learning activities, Lucas (2007) mentions that interaction may generate a sense of energy and humor. That was certainly the case for one of the authors, with trivia questions such as, which type of
Anecdotal Summary of Benefits Associated With Using Trivia Questions

Students seemed to respond well to the use of trivia questions prior to class. Following are some specific benefits that may be associated with the use of trivia questions prior to the start of each class.

Generates humor: Rapport and a sense of humor are among the characteristics students value in the faculty teaching their college courses (Faranda & Clarke, 2004). The use of trivia questions prior to class contributed to establishing a sense of rapport with students. While the exact reasons for this are unclear, students may have perceived the use of trivia questions as an indication that the faculty member cared enough about them and their learning to make the learning environment in the classroom more enjoyable. This is laudable given Leong's (2005) recommendation that faculty endeavor to “Create a learning environment where it is fun, open and interesting” (p. 131).

Indirectly fosters critical thinking skills: The use of trivia questions indirectly promoted the use of critical thinking since students relied on their tacit knowledge to generate possible answers or solutions that were then cognitively evaluated to determine their relative merit. Critical thinking skills could be developed through these activities since their involvement actively engages students in the learning process (Burbach et al., 2004). Aside from engaging in the identification of the answers to trivia questions, students often voiced skepticism about the validity of the answers. The author reminded students that all questions were pulled from the Internet, so the answers had to be correct. Obviously, this tongue-in-cheek statement generated additional laughter amongst students. The practical benefits of this, however, are worth acknowledging since the practice of evaluating the sources of information is among the important attributes associated with teaching critical thinking skills (McEwen, 1994).

Infuses variety into the learning environment: For even the most motivated students, the practice of routinely sitting through lectures that are hours long can be a daunting task. The use of trivia questions introduced an element of variety into the classroom that was well received by students.

Encourages active engagement: The potential benefits of getting students actively engaged in the learning process are well publicized. Asking trivia questions prior to class proved to be an effective way to get students engaged in the interactive process early as they offer possible answers to the questions. In many cases, this early engagement spilled over into the lectures, with students demonstrating more interest as well as involvement in the course since they were already in participation mode.

Permits mistakes in a low-stakes context: For many students, assessment of learning represents a high-stakes activity, with perceived or real consequences (e.g., course grades) associated with requisite performance. Consequently, a fear of failure or of getting the “wrong answer” may limit the willingness of some students to venture into the learning process actively unless they are certain about the results. Using the trivia questions at the beginning of each class encouraged students to make guesses, attempt answers, and offer responses without the fear of undesirable consequences (e.g., a lower grade) that might accompany incorrect responses. This often translated into a higher likelihood that students would remain engaged during course discussions by offering insights, comments, and ideas related to course content.

Using Trivia Questions—A Test

To evaluate the effectiveness of one of these strategies, one of the authors conducted a test in the business class he teaches where there is substantial class discussion. This is a class he has taught repeatedly, so he was completely familiar with leading discussions and was prepared for all class meetings. During the first half of the semester he held class with discussions as he had typically done in previous semesters. At the half-way point of the semester, the students completed a questionnaire regarding the class. At the next class meeting, the instructor announced that he would be using trivia questions to help promote student participation. At the beginning of each subsequent class meeting, with the exception of exam days, he would ask three or four trivia questions. He obtained the questions from open sources, and the questions were unrelated to the class. At the conclusion of the semester, the students completed the same questionnaire as at mid-semester with one additional question.

The survey consisted of questions modified from publically available faculty and class evaluation forms used at a variety of American universities, plus questions developed by the authors. There were nine questions selected pertaining to class structure, teaching, and student interaction all using a 6-point Likert scale where one (1) denoted “strongly disagree” and six (6) denoted “strongly agree”. The tenth question appearing on both surveys asked students to rate the instructor overall. This was included to determine if using trivia questions changed the student’s opinion of the instructor using a 10-point Likert scale. The end-of-semester, or after, survey included the following additional
question: The atmosphere of the classroom was more “fun” and “open for discussion” during this half of the semester compared to the first half of the semester. It was measured on a 6-point Likert scale. Table 1 provides a summary of the content from the survey questions.

Table 1: Summary of Content for Survey Questions

<table>
<thead>
<tr>
<th>Survey Question Number</th>
<th>Content of the Survey Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>Student interest in the course prior to registering for the course.</td>
</tr>
<tr>
<td>Q2</td>
<td>Student comfort level participating in class.</td>
</tr>
<tr>
<td>Q3</td>
<td>Role of class format in making material/content more interesting.</td>
</tr>
<tr>
<td>Q4</td>
<td>Amount of student participation in the class.</td>
</tr>
<tr>
<td>Q5</td>
<td>Level of student preparedness for class.</td>
</tr>
<tr>
<td>Q6</td>
<td>Effectiveness of instructor in encouraging student interest in the class.</td>
</tr>
<tr>
<td>Q7</td>
<td>Amount of involvement in discussions and activities.</td>
</tr>
<tr>
<td>Q8</td>
<td>Instructional approach used that helped the student learn.</td>
</tr>
<tr>
<td>Q9</td>
<td>Amount of learning for the student in the course.</td>
</tr>
<tr>
<td>Q10</td>
<td>Overall instructor rating.</td>
</tr>
<tr>
<td>Q11</td>
<td>Overall atmosphere of classroom as fun and open during second half of the semester.</td>
</tr>
</tbody>
</table>

At both survey times, the same students were enrolled in the class. The survey was conducted during a class meeting, so not all students were present. The surveys were anonymous and, thus, were not able to be matched. At the mid-semester survey, 33 of 36 enrolled students responded. At the end-of-semester survey, 30 of 36 students responded. Ideally, it should be the same students responding to both surveys. Because nearly the entire population of students in this class responded, statistical testing was not considered appropriate. Our analysis was based on the changes observed in the mean, median, and standard deviation as well as an analysis of bar charts for each question and the response to the additional question contained on the “after” survey. The statistics are summarized in Table 2.

As shown in the results, there was a positive change in the median on four of the items. Question 2 evaluated a student’s self-reported level of comfort in participating in class. The median increased from 4.0 to 5.0 on a 6-point scale with the mean increasing by 0.19 points to 4.55. As shown in Figure 1, students’ responses tended to move up the scale toward more strongly agreeing that they felt more comfortable participating in class. This may indicate that using the trivia questions did help students feel more comfortable in participating. The standard deviation was slightly reduced, meaning, if anything, the class was more unified in their sense of comfort, having reduced the proportion of students feeling very uncomfortable. This is also reflected in the chart where more than 50% of students responded with a 5 rating. This change also may be due to having fewer students responding on the end-of-semester survey.

Table 2: Distribution of Developed Cognates

<table>
<thead>
<tr>
<th>Question</th>
<th>Before (N=33)</th>
<th>Mean</th>
<th>Median</th>
<th>Std Dev</th>
<th>After (N=30)</th>
<th>Mean</th>
<th>Median</th>
<th>Std Dev</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td></td>
<td>3.24</td>
<td>3.00</td>
<td>1.28</td>
<td>3.03</td>
<td>3.00</td>
<td>1.20</td>
<td>0.00</td>
<td>-0.08</td>
</tr>
<tr>
<td>Q2</td>
<td></td>
<td>4.36</td>
<td>4.00</td>
<td>1.23</td>
<td>4.55</td>
<td>5.00</td>
<td>1.07</td>
<td>0.19</td>
<td>1.00</td>
</tr>
<tr>
<td>Q3</td>
<td></td>
<td>4.34</td>
<td>4.50</td>
<td>1.27</td>
<td>4.68</td>
<td>5.00</td>
<td>1.28</td>
<td>0.33</td>
<td>0.50</td>
</tr>
<tr>
<td>Q4</td>
<td></td>
<td>4.82</td>
<td>5.00</td>
<td>1.03</td>
<td>5.23</td>
<td>5.50</td>
<td>0.88</td>
<td>0.42</td>
<td>0.50</td>
</tr>
<tr>
<td>Q5</td>
<td></td>
<td>3.97</td>
<td>4.00</td>
<td>1.17</td>
<td>4.23</td>
<td>4.00</td>
<td>1.17</td>
<td>0.26</td>
<td>0.00</td>
</tr>
<tr>
<td>Q6</td>
<td></td>
<td>5.09</td>
<td>5.00</td>
<td>0.83</td>
<td>5.10</td>
<td>5.04</td>
<td>0.94</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>Q7</td>
<td></td>
<td>3.79</td>
<td>4.00</td>
<td>1.17</td>
<td>4.07</td>
<td>4.00</td>
<td>1.34</td>
<td>0.28</td>
<td>0.00</td>
</tr>
<tr>
<td>Q8</td>
<td></td>
<td>4.67</td>
<td>5.00</td>
<td>1.27</td>
<td>4.63</td>
<td>5.00</td>
<td>1.25</td>
<td>-0.03</td>
<td>0.00</td>
</tr>
<tr>
<td>Q9</td>
<td></td>
<td>4.76</td>
<td>5.00</td>
<td>1.02</td>
<td>5.33</td>
<td>5.50</td>
<td>0.79</td>
<td>0.58</td>
<td>0.50</td>
</tr>
<tr>
<td>Q10</td>
<td></td>
<td>8.58</td>
<td>9.00</td>
<td>1.07</td>
<td>8.50</td>
<td>9.00</td>
<td>1.63</td>
<td>-0.08</td>
<td>0.00</td>
</tr>
<tr>
<td>Q11</td>
<td></td>
<td>4.93</td>
<td>5.00</td>
<td>1.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Questions 1-9 and 11 used a 6-point scale; Question 10 used a 10-point scale.

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Question 3 asked if the class format made students more interested in the course material. This question was included because asking trivia questions could be considered part of the class format. The median response increased by 0.5 points and the mean increased by 0.33 to 4.68 points. The standard deviation was close to unchanged. As displayed in Figure 1, students’ responses moved up toward strongly agreeing. It appears they felt the class was more interesting during the period when trivia questions were included at the beginning of class. The response to this question may show that adding the trivia questions at the beginning of class was viewed by students as a positive change to the class format.

The amount of student participation that students believed was occurring in class was measured in Question 4. Here the median increased by 0.5 points, and the mean increased by 0.42 to 5.23 out of six points. The standard deviation was slightly reduced, similar to what occurred in Question 2. The increase in the median and mean shows that students perceived that there was more participation from the class as a whole since the inception of asking trivia questions, but this was limited. While Figure 1 shows that although some students moved toward agreeing that there was a great deal of student participation, others felt less strongly about this than earlier in the semester as reflected with fewer “strongly agree” responses.

There were also increases to the mean response for Question 7 regarding how much a student believed he or she actively engaged in class discussions. Here the mean increased by 0.28 to 4.07 points, indicating that students felt they participated more in the later part of the course when the trivia questions had been used. According to Figure 1, students’ responses moved toward agreeing that they were more actively engaged in class.

Question 8 evaluated the helpfulness of the instructional approach for student learning. There effectively was no change in the mean or standard deviation. This may indicate that asking the trivia questions was not viewed by students as a significant pedagogical change.

The eleventh question only appeared on the end-of-semester survey and asked students if the class seemed more open to discussion compared to the first half of the semester. The mean score was 4.93 with the median at 5.0 points on a 6-point scale. Figure 2 reveals that the majority of students (63%) agreed that the classroom atmosphere was better when class started with the trivia time. This may indicate that students perceived asking trivia questions did encourage more active engagement because the class began in a “fun” manner.

The mean score was virtually unchanged for Question 6 about the instructor’s effectiveness in encouraging student discussion. This makes sense in that asking trivia questions at the
beginning of class did not change the instructor’s personality or his ability to formulate questions, respond to student remarks, or redirect class discussions. Additionally, there was consistency of the mean for Question 10 regarding the instructor’s overall effectiveness. Both occurrences support that the positive changes noted in response to the other questions were attributed to something other than students’ general feeling about the instructor’s effectiveness.

These results and the conclusions drawn from them should be weighed cautiously. The study was limited to a single, semester-long class and single instructor. Additionally, the surveys were not matched to students in a pre- and post-test manner, and not all of the same students participated in both surveys (although a majority did). Both of these factors could impact the differences in the mean scores that resulted. In addition, a true experimental design would have included a control group, so the lack of a control group is a limitation that should be noted.

Conclusion

As previously discussed, student engagement (Handelsman et al., 2005; Rachal, Daigle, & Rachal, 2007) and the culture or environment of the classroom (Brewer, 2008) are important factors in the overall learning process. This article outlined the use of music and trivia questions as possible pre-teaching strategies that may have positive implications on both student levels of engagement and the overall environment of the classroom. The anecdotal benefits summarized in this article may be bolstered by future studies designed to examine these two strategies empirically through appropriate experimental designs.

It is worth noting that the practical value of these strategies may be influenced by class size, with maximum utility associated with smaller classes where faculty can more actively engage with a larger portion of the class (Ramsey & Fitzgibbons, 2005). Class size is also important to consider given Arias and Walker’s (2004) evidence that smaller class size may be related to better student performance. For example, it may not be practical or manageable to ask pre-class trivia questions to class sections with 40 or more students. Likewise, it may be difficult to use music in larger class sections as a conduit for student engagement or interactive discussions about music. However, the potential value of playing music in the background prior to class may have merit regardless of class size if the sole objective is to create a more relaxed classroom environment prior to the start of course lectures.

A final point worth noting is that the value of using music and trivia questions could likely be enhanced through efforts to match music elements and trivia questions more directly to course content. For example, it might be interesting to explore how important events in the external environment may influence new music or songs. Students could be engaged by asking them to identify songs that mention important economic or political events. Likewise, instructors could play songs that they perceive as influenced by salient events and then facilitate discussions tapping into students’ perceptions. Trivia questions could also be tailored to specific course content to more actively engage students in learning course material. For example, a lecture on the importance of brand recognition and market presence may be enhanced by showing logos or trademarks of popular companies and then asking students to identify the names of the companies. This could also facilitate a discussion about company mottos, mission statements, and values.

Using music and trivia questions represent two examples of strategies that might have positive implications in the college classroom. A single class was selected to test the use of trivia questions before class. It showed that incorporating the use of trivia questions may lead students to feel that the environment of the class was more fun and open to discussion, that students participated more, and that the course was more interesting.

Instructors are encouraged to adapt these strategies in ways that best facilitate learning in the context of their classrooms. Exploring other novel or unique strategies might help identify additional methods for faculty to consider in their quest to enhance overall student learning.

References:


Blending the Best of Both Worlds: Overcoming Skepticism in a Hybrid Engineering Course

Susan L. Murray, Kelly L. Jones, and Julie A. Phelps

Abstract
In a blended (or hybrid) course a portion is taught face to face in a classroom and at least one-third of the coursework is online. Students receive personal contact and interaction with the instructor during the classroom portion and also have flexibility in the pace, access, and repetition of online content. In this article, we explore 49 graduate engineering students’ expectations for a required operations management course that was redesigned from a traditional to a blended format. The majority of these students had no prior experience with blended (77.6%) or online (55%) courses. The pre-survey showed students were hesitant or unsure about taking a blended course. The same students were also surveyed at the completion of the course to determine how their expectations matched with their experiences. Most of the students (85%) expressed the desire to take another blended course based on their experience in this course.

Keywords
Higher Education, Student Satisfaction, Online Classes, Engineering

Introduction
There has been an explosion in online courses over the last decade at institutions of higher education across the United States and elsewhere. According to I. Allen and Seaman (2013), 6.7 million students, about 32% of the higher education student population, took at least one online course in 2011. The growth of online courses in engineering programs, however, has been slower than other fields of study (Allen, Artis, Afful-Dadzie, & Allam, 2013; Kinney, Liu, & Thornton, 2012; Bourne, Harris, & Mayadas, 2005). Many instructors are hesitant to attempt to teach difficult subjects, such as engineering and mathematics online; consequently, online learning has not become as popular in engineering education as in other disciplines (Allen et al., 2005; Kinney et al., 2012). However, that perspective may be changing as new learning technologies provide greater pedagogical potential, and new formats such as blended learning are developed and practiced (Allen et al., 2013; Kinney et al., 2012). Blended learning combines elements of traditional classroom-based instruction with newer digital online learning experiences. Students attend face-to-face classes with the instructor for parts of the course and complete online coursework in between face-to-face meetings. Blended courses may enhance student satisfaction and engagement (Kuo, Belland, Schroder, & Walker, 2014). Blended learning offers substantial potential for teaching and learning in higher education and may be an effective pedagogical design for many types of engineering courses. Bourne, Harris, and Mayadas (2005) observe, “It is likely that the first movement toward more online learning will come in blended environments in which courses are offered on campus but with a significant online component” (p. 141). This research sought to determine if there was a difference in students’ perceptions of blended learning before and after taking a newly redesigned blended course. Our goal was to explore whether students in a graduate engineering management course were reluctant to take a blended course and to see if those student views changed after completing such a course.
Redesigning a Graduate Engineering Management Course as a Blended Course

This study examined students’ expectations and experiences in a required course in operations management in the engineering management master’s degree program at Missouri University of Science and Technology (S&T). The class is typically taught multiple times a year, both face-to-face and live streaming over the Internet for distance students. The engineering management master’s degree is a “broadening” degree. Students enter the program with a bachelor of science degree in almost any engineering and science focus imaginable. The students received their prior education either domestically or internationally. Some have just finished their bachelor’s degree, and others have not taken a class in more than 20 years. This results in widely varied levels of preparation among the students and wide-ranging instructional needs. The required master’s course is typically taken in the student’s first semester. It is often the most difficult course for the students due to its quantitative nature. It is a challenging course for faculty due to the wide range of students’ abilities and backgrounds. In 2014, the class was redesigned as a blended course from a traditional three-credit hour, face-to-face format. The students did not have a choice of class format. It was the first time the class was taught in a blended format and was the first semester in the master’s program for all of the students. This limited students’ prior knowledge and expectations for the blended class structure. All of the other classes in the students’ degree program were in a traditional, face-to-face format.

Literature Review

The review of related literature is organized into three major themes: engineering education and online learning, an overview of blended learning, and the importance of social presence in blended courses.

Online Learning and Engineering Education

Early research (Angulo & Bruce, 1999) showed most students would not consider taking a course that had a significant amount of web-based content in place of class meetings. Martinez-Caro and Campuzano-Bolarin (2011) explain, “Previous research explained that e-learning is generally most effective when used as a supplement to, rather than a replacement for, engineering education” (p. 473). Allen, Artis, Afful-Dadzie, and Allam (2013) note that while students still report a preference for face-to-face classes, online programs continue to increase. Online learning is a major part of the higher educational landscape today, and online programs are growing at a dramatic rate, but this trend is not as strong in engineering education where most online programs are offered only at the graduate level (Allen et al., 2013; Bourne et al., 2005; Kinney et al., 2012). Bourne et al. (2005) observe, “Engineering education has traditionally had various delivery-centered constraints. Online methodologies will ultimately assist in equipping graduates to learn more broadly and deeply and to become lifelong learners” (p. 135). Blended learning, which combines traditional, face-to-face class time with new online course delivery, may open new doors of possibilities in engineering education (Allen et al., 2013; Bourne et al., 2005; Kinney et al., 2012).

Blended Learning: The Best of Both Worlds?

Definitions of blended learning, sometimes called hybrid, vary greatly, and colleges use different measurements of online and face-to-face content to define blended in the context of each individual institution. Allen and Seaman (2013), in partnership with the Online Learning Consortium (formerly Sloan-C), classify courses with between 30 and 79% of instruction delivered online as blended. Blended learning is a growing trend, with at least 55% of colleges and universities in the United States offering at least one blended course (Allen & Seaman, 2013; Kuo et al., 2014). Blended learning is growing in popularity, particularly among graduate students who value flexibility and graduate schools that want to reach more students (King & Arnold, 2012). Blended learning may be the “third generation” of distance education (Kuo et al., 2014, p. 361) due to ways in which it combines features of both on-ground and online instruction (King & Arnold, 2012). Martinez-Caro and Campuzano-Bolarin (2011) studied modes of instruction and report, “Student satisfaction was significantly greater in blended courses than in face-to-face courses” (p. 480). Possible advantages of blended learning include learner-centered course designs, flexibility in scheduling for students and the institution, cost savings, increased student satisfaction and engagement, and fewer students dropping courses than in completely online learning (Bourne et al., 2005; King & Arnold, 2012; Kuo et al., 2014). For engineering education, blended learning may offer significant opportunities. Martinez-Caro and Campuzano-Bolarin (2011) state, “Blended learning appears as a solution to the need to update traditional engineering classes because of demand from a society motivated by the strong upsurge of information and communication technologies” (p. 480). There are also possible disadvantages with blended learning. First, unlike online learning programs, blended courses are only available to students who are able to travel to campus for assigned face-to-face meetings, which may limit the geographic reach of a blended learning program. Second, blended learning can be ineffective and disengaging if instructors do not blend key course components in the most well-suited delivery mode when combining face-to-face and online instructional methods (Ally, 2008; Bourne et al., 2005; Carman, 2005; King & Arnold, 2012). Third, blended
courses, if done well, are time consuming to design and to teach. Blended learning may impose serious demands on instructors’ time. King and Arnold (2012) advise, “Facility need to be prepared for the initial time commitment involved in preparing a blended course. Sometimes a complete course redesign is necessary which can require extensive time and resources on the professor’s part” (p. 2).

The Critical Ingredient: Social Presence

It can be difficult for students in online environments to connect with their instructors. Most online courses are heavily text-based, and the instructor can be seen as an invisible force on the other end of the network connection (Clark & Mayer, 2011). Lowenthal and Dunlap (2010) state that students in online courses often report feelings of loneliness and isolation; therefore, instructors teaching online, blended, and distance courses should establish trustworthiness with students by being visible and maintaining a strong social presence (Aragon, 2003).

In technology-mediated communication, social presence is defined as the “degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships” (Short, Williams, and Christie, 1976 as cited in Aragon, 2003, p. 65). Bourne et al. (2005) describe social presence as “a key determining factor in whether people learn well online” (p. 133). Therefore, instructors’ social presence may be the key ingredient to creating successful blended courses. Martinez-Caro and Campuzano-Bolarin (2011) report, “Class attendance, access to teacher, collaboration with classmates, and motivation were found to be predictors of satisfaction in blended environments, with access to the teacher being the strongest predictor of all” (p. 481). The importance of instructor presence in blended courses should not be underestimated.

Research supports the significance of social presence in online learning (Clark & Mayer, 2011; Sung & Mayer, 2012; Akyol & Garrison, 2008); therefore, instructors need practical strategies and examples to help them establish a strong sense of presence (Baker & Edwards, 2011; Jones & Phelps, 2014; Lowenthal & Dunlap, 2010). As noted by Baker and Edwards (2011), instructors who establish and maintain social presence with students online are more successful than instructors who do not. Designing a blended course with strong social presence is difficult and time consuming; however, it appears that investments of time and effort in building and strengthening social presence in online and blended courses yields positive learning outcomes for students.

Blended Course Design Rationale and Key Elements

Effective blended courses require effective instructional designs. King and Arnold (2012) explain, “It is not enough to simply ‘slap’
was delivered through Missouri S&T’s learning management system, Blackboard. It was designed with careful attention to the organization and quality of the instruction videos, online course content, and online course structure. Carman (2005) recommends five elements for designing blended courses based on a blending of instructional design theories: live events, online content, collaboration, assessment, and reference materials. Each module in this engineering management blended course includes:

- **Live events:** In-class content, including the PowerPoint slides and examples used in the classroom. Each module is introduced by the instructor and the textbook readings. The face-to-face class meetings focused on application of content to real-world problem solving.

- **Collaboration:** During the face-to-face class meetings, students worked on problems in small groups, and they also worked in small groups on a modeling project together outside of class.

- **Online content:** This content included video clips focused on problem solving. The instructor created several of the videos that included her voice, increasing instructor presence. Other videos were curated from instructor-reviewed sources. Students were encouraged to work interactively with the short videos. They were allowed to proceed at their own pace and repeat the material as needed. The instructor decided to include videos in every module to “help bridge the gap between faculty and students when not meeting face-to-face” (King & Arnold, 2012, p. 3).

- **Assessment:** Assignments, including reading assignments and homework problems continued to be assigned to students in the blended course, similar to what was done in the traditional course. At the end of each module, students completed a graded assessment activity. A multiple-choice quiz was provided and graded by the learning management system, providing immediate feedback to the student on his or her understanding of the material.

- **Reference materials:** In addition to the required textbook and online videos, the course site also contained bonus content geared toward the students who were excelling and wanted more material. This is optional content that is not covered in a traditional class due to time constraints.

Forty-nine students completed this new blended course and there were no withdrawals. The course lasted eight weeks, with face-to-face meetings every week.

**Methodology**

In this exploratory study, students’ attitudes about the structure of the course and the flexibility of the blended model were assessed through pre- and post-surveys. The questions on the pre-survey were revised and repeated on the post-survey. Additional questions were added to evaluate the students’ actual experiences. The learning management software (Blackboard) and streaming video analytics (Kaltura) were used to track when, how often, and how long students accessed the educational material (required assignments, video of problem solutions, and bonus materials). The surveys were administered on the first day of class and after the final exam. The pre-survey was on paper and the post-survey was online; the students remained anonymous for both.

The pre-survey explored students’ prior experience with blended and online courses. They were asked how prepared they felt for the graduate class based on their previous coursework and knowledge of the class subject. The remaining questions used a Likert scale to explore their expectations of the class in general and in comparison to a traditional face-to-face class. The post-survey consisted of 23 statements with a five-point Likert scale ranging from “strongly agree” to “strongly disagree”. This survey provided
an assessment of their experience and an opportunity to compare their expectations before the class with their actual experiences.

The class enrollment was 49 graduate students. All 49 students participated in the survey and, of that, seven (14%) were female. They rated their level of computer expertise as novice (6%), intermediate (76%), and expert (18%). Seventy-seven percent had not taken a blended class prior to this course. Their experience with online classes varied: 0 (55%), 1 (6%), 2 (14%), 3 (12%), 4 (8%), and 5 or greater (4%). Based on previous coursework their self-perceived level of preparation varied: strongly prepared (8%), prepared (20%), somewhat prepared (31%), unprepared (39%), and strongly unprepared (2%). The majority of students had no prior experience with blended (77.6%) or online (55%) courses. The pre-survey showed students were hesitant or unsure about taking a blended course.

Results

Before the course began, only 5% of the students believed that they would have a successful learning experience in a blended course. However, the post-course survey showed that 85% of students felt that the blended course format helped them be more successful in learning the course material. The majority of students (85%) expressed the desire to take another blended course based on their experience in this class. Table 1 summarizes the students’ expectations of the blended course prior to taking the class. It shows a combination of uncertainty and reservation about participating in a blended course.

Table 2 summarizes the students’ experiences taking the blended course. At the end of the course, the post-survey included the statement, “The online content motivated me to do more learning/studying than I would have done otherwise.” Most students “strongly agreed” (21%) or “agreed” (29%) with the statement and fewer “disagreed” (15%) or were “neutral” (35%). The vast majority of students (96%) felt that being able to work on the online content at their own pace was beneficial. Only two students (4%) felt they were not able to learn material equally well in the online and traditional portions of the class.

When comparing student performance in the blended course with students in a prior traditional face-to-face section of the same course taught by the same instructor, the grades were slightly better in the blended class. The homework assignments were the same for the two classes, and the exam questions were similar in difficulty and concepts tested, but different specific questions were used to avoid an unfair advantage for latter students with copies of the old exams. Overall, the course grades were within one standard deviation of each other with the blended class having a higher average.

The campus uses an online teaching evaluation completed anonymously by students using a four-point scale. The overall

Table 1: Pre-Survey Student Opinions

<table>
<thead>
<tr>
<th>Opinion</th>
<th>1 Strongly Agree</th>
<th>2 Agree</th>
<th>3 Unsure/Neutral</th>
<th>4 Disagree</th>
<th>5 Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>A blended class will be beneficial.</td>
<td>0%</td>
<td>5%</td>
<td>26%</td>
<td>45%</td>
<td>24%</td>
</tr>
<tr>
<td>A blended class will allow me to be successful.</td>
<td>0%</td>
<td>5%</td>
<td>52%</td>
<td>33%</td>
<td>10%</td>
</tr>
<tr>
<td>I would prefer to take a traditional class instead of a blended one.</td>
<td>0%</td>
<td>5%</td>
<td>51%</td>
<td>34%</td>
<td>10%</td>
</tr>
<tr>
<td>A blended and traditional course will be equally effective ways to learn.</td>
<td>2%</td>
<td>5%</td>
<td>57%</td>
<td>29%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Table 2: Post-Survey Student Opinions

<table>
<thead>
<tr>
<th>Opinion</th>
<th>1 Strongly Agree</th>
<th>2 Agree</th>
<th>3 Unsure/Neutral</th>
<th>4 Disagree</th>
<th>5 Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Being able to work through online material at my own pace was beneficial.</td>
<td>67%</td>
<td>29%</td>
<td>2%</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>A blended class helped me to be more successful in learning course material.</td>
<td>48%</td>
<td>35%</td>
<td>15%</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>The online content motivated me to learn/study more than I would have otherwise.</td>
<td>21%</td>
<td>29%</td>
<td>36%</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>I would like to take another blended in the future.</td>
<td>65%</td>
<td>21%</td>
<td>20%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>I was able to learn through the online and classroom components equally well.</td>
<td>56%</td>
<td>31%</td>
<td>8%</td>
<td>4%</td>
<td>0%</td>
</tr>
</tbody>
</table>
campus average was 3.10, and the average for the blended class was 3.83, which is significantly higher than the campus average and higher than the instructor's average of all classes taught at 3.55 that year.

Discussion: Lessons Learned

For instructors and instructional designers developing a blended course, we would offer the following suggestions:

• Make the explicit, implicit. You will see the students less often. Deadlines, policies, and the like must be clear to the students as they work alone.

• Determine what material is best suited for face-to-face class meetings and for online learning. A great deal of thought should be given to what material students will want and need personal interaction with the instructor. What material will students wish to see repeated (such as detailed problem solving, steps using computer software, etc.)? This type of material may be best suited for online delivery. What problems will students want to discuss with the instructor, and what misconceptions or knowledge gaps could make learning content more challenging? Those topics may be best suited for face-to-face class meetings.

• Be very organized. Students need to understand clearly what they are expected to do in class, outside of class, and online.

• Be consistent. Where is material located? The online content should be formatted consistently.

• Be purposefully present. The instructional development literature on social presence for instructors in online learning is significant. Ensure the instructor’s “voice” is present in the online content. Instructor-created videos may promote social presence in blended and online courses (Jones & Phelps, 2014). Respond to students’ questions quickly and provide timely feedback on assessments.

• Make materials easy to update. The first time a class is offered in the blended format, it will be very labor intensive. Minimize what needs to be changed when the class is offered repeatedly. For example, referring students to the schedule rather than giving specific dates or chapters can prevent the need to record a video again (Jones & Phelps, 2014).

• Reflect on the blended teaching and learning experience. King and Arnold (2012) recommend that instructors take time at the end of a blended course to review what went well and what areas of the course could be improved. Additionally, instructors should continue to look for new scholarship and creative ideas to support best practices in blended learning.

Conclusion

This exploratory study was designed to examine graduate students’ perceptions of blended learning before and after they completed a newly redesigned blended engineering management course. The differences between the pre- and post-surveys were striking. The graduate students had uncertainty and reluctance to participate in a blended course. However, after experiencing the benefits in flexibility and work pace, the vast majority of students stated positive views about the experience and the concept of blended education, in general. The students’ performance and grades were comparable to sections of the class that were taught face to face by the instructor previously. The instructor’s teaching evaluations were also higher for the blended class than prior evaluations. Results of this study indicate that as engineering educators, we need to educate students about blended courses and expect reservations among students in blended courses compared to those in traditional face-to-face courses. Sharing students’ positive experiences with blended courses may also help with marketing blended courses to engineering students who may be reluctant or fearful of registering for these new course formats.

Recommendations for Future Research

Additional research is needed to design effective blended learning courses for graduate engineering education. Blended learning delivery models and methods will likely continue to grow and become more prevalent in engineering education (Bourne et al., 2005). Consequently, it is important for instructors to gauge students’ perceptions and reactions to blended learning experiences and to share blended learning resources and strategies. To develop best practices for blended learning in engineering education, future studies are needed to add to our understanding of students’ attitudes and performance in blended courses and to examine what types of learning activities are best suited for a blended course design. Such future studies could compare engineering students’ perceptions and performance in face-to-face, online, and blended courses. Other topics viable for future research include the impact of instructor presence in blended learning courses, comparisons of students’ expectations with their experiences in blended courses, instructors’ perceptions of blended learning in engineering education, and student outcomes in blended learning engineering programs.

Acknowledgements

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References:


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Quality Approaches in Higher Education

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The American Society for Quality’s Education Division publishes the online, double-blind, peer-reviewed journal *Quality Approaches in Education*. The editorial team actively encourages authors to submit papers for upcoming issues.

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- Case studies or research studies on scholarship of teaching and approaches to improve teaching, enhancing and supporting student learning, learning outcomes assessment best practices, and best practices for using technology in the classroom.
- Case studies or research studies on how student service units and intervention programs impact the quality of student experience and student learning.
- Case studies or research studies specific to collaboration with industry on STEM education through internships, co-ops, and capstone experiences for providing experiential and deep learning experiences and preparing students for STEM careers.
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- Case studies that highlight the emerging improvement science for education and the continuous improvement cycle.
- Significant conceptual articles discussing theories, models, and/or best practices related to quality in higher education, K-12, and workforce development.

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Please send your submissions to:

Dr. Elizabeth Cudney at QAHE@asqedu.org
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Manuscript Review Process

We log all article submissions into a database and delete all references to you. These “blinded” versions then go to the editorial review team for comments and recommendations. Both author(s) and reviewers remain anonymous in this process. The review process takes approximately three months during which time the reviewers advise the editor regarding the manuscript’s suitability for the audience and/or make suggestions for improving the manuscript. Reviewers consider the following attributes:

1. Contribution to knowledge: Does the article present innovative or original ideas, concepts, or results that make a significant contribution to knowledge in the field of quality in education?
2. Significance to practitioners: Do the reported results have practical significance? Are they presented clearly in a fashion that will be understood and meaningful to the readers?
3. Conceptual rigor: Is the conceptual basis of the article (literature review, logical reasoning, hypothesis development, etc.) adequate?
4. Methodological rigor: Is the research methodology (research design, qualitative or quantitative, methods, survey methodology, limitations, etc.) appropriate and applied correctly? For a conceptual paper, is the framework appropriate and applied correctly?
5. Conclusions and recommendations: When appropriate, are the conclusions and recommendations for further research insightful, logical, and consistent with the research results?
6. Readability and clarity: Is the article well organized and presented in a clear and readable fashion? Is the article written in English and in a grammatically acceptable manner?
7. Figures and tables: When submitted, are the figures and/or tables used appropriately to enhance the ability of the article to summarize information and to communicate methods, results, and conclusions?
8. Organization and style: Is the content of the article logically organized? Are technical materials (survey scales, extensive calculations, etc.) placed appropriately? Is the title representative of the article’s content?
9. Attributions: Are the sources cited properly using APA style? Are attributions indicated properly in the reference list?

You should use these attributes as a checklist when reviewing your manuscript prior to submission; this will improve its likelihood of acceptance.

Review Process Outcomes

There are three possible outcomes of the review process:

- Accept with standard editorial revisions. In this case, the content of the article is accepted without requiring any changes by you. As always, however, we reserve the right to edit the article for style.
- Accept with author revisions. An article in this category is suitable for publication, but first requires changes by you, such as editing it to fit our length requirements or providing more detail for a section. We provide specific feedback from our reviewers to guide the revision process.
- Decline to publish. Occasionally articles are submitted that do not fit our editorial scope. We may provide you with suggestions for modifying the article to make it more appropriate to our publication.

Please note that after articles are edited for publication, we return them to you to approve the technical content. A response may be required within 48 hours or the article may be held over for a subsequent issue. Articles that appear to be advertising or do not fit the general topics addressed by Quality Approaches in Education will be rejected without receiving peer reviews.
Author Guidelines

1. Articles should emphasize application and implications of what is being presented, whether conceptual or research-based.
   - Use the early paragraphs to summarize the significance of the research.
   - Make the opening interesting; use the opening and/or background to answer the “so what?” question.
   - Spell out the practical implications for those involved in education.

2. Detailed technical description of the research methods or conceptual/theoretical framework is important, but not necessarily of interest to everyone. The description should enhance the narrative or be critical to the understanding of the article’s material.

3. Throughout the article, keep sentence structure and word choice clear and direct.

4. Avoid acronyms and jargon that are industry- or organization-specific. Try not to use variable names and other abbreviations that are specific to the research. Restrict the use of acronyms to those that most readers recognize. When acronyms are used, spell them out the first time they are used and indicate the acronym in parentheses.

5. Occasionally, our reviewers and readers view articles that include reference to the author(s) proprietary products or methods as a form of advertising. Although we encourage you to share personally developed theories and application approaches, we ask that you refrain from using our publication as a marketing tool. Please take great care when including information of this nature in your article.

6. If the article cites cost savings, cost avoidance, or cost-benefit ratios, or provides the results of statistical evaluations, include an explanation of the method of calculation, along with any underlying assumptions and/or analysis considerations.

7. Access to any survey discussed in the manuscript is important for our review and must be included with the manuscript. Depending on the length of the survey, we may include the entire survey with the article.

8. When submitting an article that is based on qualitative methodology, please be sure to describe the research questions, the information that is the basis of the data analysis, and report the developing themes. Also remember to include text analysis as part of data analysis. Please include the protocols in a separate Word document; review of the protocols will be important in our technical review. Consider including the protocols in the methodology section of the manuscript, if they can be presented concisely.

9. Our staff does not have the means to compile references or verify usage permissions; therefore, it is important for you to provide all that information with your article, including written letters of authorization when appropriate. Plagiarism is a rapidly growing crime—particularly due to the use of information from the Internet. Please help yourself, and us, to maintain professional integrity by investing the time necessary to verify your sources and to obtain and document all necessary permissions. Information on our requirements for documenting references, along with specific examples, is included at the end of these guidelines.
Submission Format

1. We accept only electronic submissions in Microsoft Word format. The first page should be a title page with the title, names of the authors, and their affiliations. The second page should be the start of the proposed article with the title and abstract (150 words maximum) at the top of the page. There should be no reference to the author(s) or affiliation in the text that follows. Instead of the name of a university for a case study, the text should state “the University”. The margins should be one inch all around on 8½ x 11 pages with Word’s one-column format, left-justified. The title and section titles should be 14-point bold Calibri font. The text font should use 11-point Calibri font and a line spacing of 1.5 is preferred.

Section headings should be 12-point bold Calibri and left justified. Typical section names are: Abstract, Introduction, Background, Literature Review, Methodology, Results, Discussion, Suggestions for Best Practices, Summary or Conclusions, Recommendations, Future Work/Research, Acknowledgments, and References. The actual headings will depend on the focus of the manuscript. There may be two additional levels of sub-headings. The first set of subheadings would be left-justified with the first letter of each word capitalized and in bold, 12-point Calibri. The second level of sub-headings would be the same but in italics.

2. If you are familiar with the APA formatting, we prefer the APA format, but will accept a well-formatted manuscript following these already mentioned guidelines.

3. The manuscript should be between 3,500 and 5,000 words including the abstract, tables, and references. It should include no more than six tables or figures. If you feel strongly that more tables or figures are needed to support the manuscript, we ask that you submit the additional tables or figures and provide an explanation for including them.

4. Tables should be included at the end of the article and must be in Microsoft Word. Each table must be referenced in the article and labeled and centered on a separate line, such as <Insert Table 1 About Here> with the caption for Table 1 on the next line, such as Table 1: Graduation Rate by Major. Do not embed .jpg, .tif, .gif, or tables in other similar formats in your article.

5. Drawings, graphs, and other illustrations should be sent in an email as separate .jpg files with 300dpi; each item should be included in a separate file. All drawings and other illustrations must be referenced in the article, and must be labeled and centered on a separate line, such as <Insert Figure 1 About Here> with the caption for Figure 1 on the next line: “Figure 1: Pareto Analysis of Student Participation in Department Activities.”

6. We can use photos if they enhance the article’s content. If you choose to submit a photo with your article, it must be a high-resolution .jpg or (at least 300 dpi and at least 4” by 6” in size). Photos should be sent in separate files and referenced in the article. Photos should be accompanied by a complete caption, including a left-to-right listing of people appearing in the photo, when applicable. Do not include any text with the photo file. All persons in the photo must have given permission to have their photo published in Quality Approaches in Education.

7. Also submit a separate high-resolution electronic photo (at least 300 dpi) for each author. Author photos should be at least 1” by 2”. Author photos should have a plain background, and the author should be facing toward the camera. Please include a separate Word document with a 75- to 100-word biography for each of the authors, mentioning the place of employment, as well as contact information.
Citations and References

Quality Approaches in Education follows the 6th edition of the Publication Manual of the American Psychological Association. Citations and references should use the (author's last name, year of publication) notation in a citation in the text and use the APA style.

The reference section should be headed with the section heading of “References” and all references are to be listed alphabetically by the first author's last name. Each reference should list all authors. List the online URL with a hyperlink. Retrieved date is not needed. Here are some examples:

**Book examples:**


**Journal article examples:**


**Reference example:**


If the authors cite their own work, they should simply state (Author, year) and the same in the reference list (no title) in the initial manuscript (since the reviews are double-blind).

One of the most common errors we have observed with submitted articles is improper referencing due to improper attribution in the text and reference section. Please make sure that all the material in the submitted article is properly referenced and cited as appropriate.

Submission

Send an electronic copy of the Word document of the manuscript including the title page, abstract, text of the manuscript, acknowledgments, and references, with a separate file of any surveys used, separate .jpg files of the figures and photos of authors, and a Word document of the author biographies to Dr. Elizabeth Cudney at QAHE@asqedu.org.

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