ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

2017 Pacific Southwest Section
Meeting: Tempe, Arizona Apr 20
Paper ID #20659

Increase student's learning and performance during an engineering introductory class for civil engineering and construction engineering management.

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Increase Student’s Learning and Performance during an Engineering Introductory Class for Civil Engineering and Construction Engineering Management.

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Abstract
Students lacked interests and motivations during a one unit engineering introductory class (CE101: Introduction to Civil Engineering and Construction Engineering Management, general education [GE] class). Most student's performance for group projects (term paper, presentation and prototypes combined with two assignments) was unsatisfied, which all combined worth more than 50% of the class grades. Two hypotheses were created prior to improving student grades. Accordingly, several instruction strategies were implemented during spring and fall 2016 semesters. The results obtained from midterms and final exams among 4 consecutive semesters, showed the spring and fall 2016 (strategies implemented) exam scores did not display a significant increase of student performance on both exams compared to spring and fall 2015. However, compared data of both exams between spring and fall 2016 (strategies implemented), fall 2016 results were slightly improved. For student presentation and prototype grades, the data from spring and fall 2015 (before strategies utilized) and spring and fall 2016 (strategies carried out), displayed no significant increase of student's grades. Conversely, the student's performance for the term paper category was slight improved from fall 2015 to fall 2016 (77.0±20%, 92.1%±5.7% and 95.1%±3.5 for fall 2015, spring 2016 and fall 2016, respectively) when 90.3%±2.1% was observed in spring 2015. Our outcomes demonstrated inconclusive impacts of the implementations because of several possibilities such as exam modification, rubric changing and large student diversity (freshmen to seniors), which may contribute to ambiguous influences of these supplementary teaching strategies.

Introduction

The feedbacks from government and industry have showed that engineering graduates lack of professional awareness, insufficient levels of communication and low teamwork skills[1-5]. Accordingly, several novel engineering educations have been proposed since the end of the 20th century. The examples of additional emphases beyond science and engineering principles are (i) real-world engineering design and operations combined with quality management, (ii) communication and teamwork skills, (iii) critical and creative thinking abilities, (iv) ethics practices and (v) connecting between technology and society[6]. Additionally, for civil engineering curriculum, interdisciplinary among all engineering disciplines is needed. For instance, a design methodology combines the answers to all the demand of the structure, an integrated design project[7]. Moreover, other professions such as social, environmental and economic issues should be included[8]. Accordingly, many of emerging concerns associated with future engineering educations are integrated in CE 101 class prior to early preparing our students toward their graduation. Our CE 101 class contents are provided in the next section.

CE 101 Class Information

The introduction to civil engineering and construction engineering (CECEM) management course is a one unit general education (GE) course and a required course for all CECEM students. CE 101 contents include several components, including (i) civil engineering and construction engineering management as a profession, (ii) current trends and challenges, ethical, social and environmental issues in professional practice, (iii) professional organizations and licensure combined with (iv) communication and lifelong learning skills for professional practice. A 50 minute lecture is arranged once a week for a total of 14 lectures for one semester. An approximate 5 to 6 lectures are provided by guest speakers, entailing two CE and CEM advisors, College of Engineering (COE) librarian, and several student chapters. Furthermore, 3-4 lectures are for group presentations. The course outline and grading criteria for CE 101 are standardized and employed for different sections. The students are evaluated from attendance (5%), assignment (15%), midterm exam (15%), final exam (15%), term paper (20%), presentation (15%) and prototypes (15%). Importantly, CE 101 is assessed for four different student's learning outcomes during Accreditation Board for Engineering and Technology (ABET), which are listed below.

(i) outcome ***f***:

- I. P.I.1. Awareness of ethical codes of conduct

(ii) outcome ***g***:

- I. P.I. 1 Ability to formulate thoughts in a cogent, well-structured and organized manner in a written format.
- II. P.I. 3 Ability to prepare and utilize a variety of visual aids in both written and oral formats.

(iii) outcome ***i***:

- I. P.I.1 Ability to use library and online resources for class projects
- II. P.I.2 Ability to use and critique current and relevant articles

(iv) outcome ***j***:

- III. P.I.1: Demonstrates knowledge of current issues and state-of-the-art in Civil Engineering;
- IV. P.I.2: Ability to describe how current trends and technologies affect the implementation of engineering solutions.

Problem Statements: Spring 2015 and Fall 2015 Student Performance

From previous semesters, the students lacked interests and motivations during the lectures, especially when the guest speakers were present. Thus, two quizzes (in-class) were created and distribute to the students for enhancing student's class engagement during two guest lecture sessions. Moreover, term paper, presentation, prototypes and two of assignments were group work. All of them were mostly graded based upon the group performance. The student grades for this group work were fairly low. This was possibly caused by lacking effective team work and insufficient knowledge to complete the tasks because the work was based on their after-class projects with no additional lectures for covering components required in each group-work. Term paper, presentation and prototypes grades combined were 50% of the class grades. Moreover, there is no prerequisite for this course. The student population includes freshmen, sophomores, juniors, seniors. Some students take this class during their last semester prior to graduation. Hence, there are extensively divergent students' experiences and backgrounds each semester. Prior to address these issues, two hypotheses were set up and tested in 2016.

Hypothesis

The hypotheses were created and tested in order to improve the student performance for the lectures and group projects. The group projects were based upon student's research and life-long learning. There was no lecture associated with the student's project work.

> ***Hypothesis 1***: Students had difficulty comprehending important contents in each lecture. Hence, providing a conclusion handout for each lecture combined with additional review lectures before midterm and final exams would improve students' exam scores.

Hypothesis 2: Students did not receive sufficient materials and guidance for their group projects. Accordingly, several instruction strategies were modified and applied. For example,

- Using the same project category as the group projects. For examples, each group was assigned two different bridges. Each group researched on different bridges.
- Prototypes of each group were submitted on the same day (last day of the class)
  Remark: prototypes were models of structures such as bridges or dams. They can be built for the entire structure or a part of the structure such as roofs or columns.
- Setting three additional small assignments (assignment 3) that required students to start working in their projects early in the semester.
  Remark: assignment 3 required each group to describe the progress of their group on term papers for each section (with a draft) combined with the prototype ideas.
- Providing clear guidelines for each of their group work.
- Sharing the grading rubrics and previous high-scored student group projects to the class.

These would assist the students while they were working on the projects during the semester. Accordingly, this possibly increased the student's grade in term paper, presentation and prototype categories.

These teaching strategy modifications were implemented for CE101 in spring and fall semester 2016. There were 3 sections of CE101 each semester. However, the strategies were applied during spring and fall 2016 semesters, which was instructed by the author. The author has been teaching CE101 since spring 2013. The total number of enrolled students in CE101 were 30 and 31 for spring and fall 2016, respectively. This class was not considered as a low completion rate course.

An Assessment Plan and the Instruments Employed

Quizzes were continuously given for two guest lectures. Scores from the quizzes were not included in the class grade. During the midterm and final exams, the topics that were quizzed were compared with the topics that were not quizzed in the classroom at the end.

Term paper, Presentation and Prototype Building were scored as 50% of the final grade and they came toward the end of the class. For the term paper, students were requested to submit the progress reports with a draft for each section during the semester. Then, the results were compared with the CE101 student's work from last semesters.

The prototypes section was redesigned. Normally, each group is assigned to different projects such as 1) comparing two bridges, 2) comparing two buildings, 3) comparing two tunnels etc. In spring 2016, all groups worked on bridges (different types of bridges). Early, the prototypes were displayed during the presentations. For spring 2016, prototypes were displayed at the same time in week 16. Table 1 summarizes the supplementary teaching strategies in each semester.

Table 1 The supplementary teaching strategies in each semester.

Supplementary teaching strategy	Spring 2015	Fall 2015	Spring 2016	Fall 2016
Conclusive handout for each lecture			Y	Y
Midterm exam reviews			Y	Y
Final exam reviews			Y	Y
Same group project category			Y	
Prototype submission on the same day			Y	Y
Grading rubrics provided			Y	Y
Work examples provided			Y	Y
Comments on term paper draft provided			Y	Y

Remark: Y indicating teaching strategy implemented

Results and Discussion

The student's midterm and final exam scores (%) from spring 2015 to fall 2016 (S2015-F2016) are displayed in Figure 1 and Table 2. In spring 2016 (strategies implemented), the midterm and final exam scores were 77.96%±8.54% and 77.73%±10.33%, respectively. Compared data of midterm exam grades among 3 consecutive semesters, our S2016 result did not show a significant increase of student performance on this category. Similarly, the significant increase of students' final exam scores in S2016 was not observed compared to S2015 and F2015. However, it was clearly seen that the standard deviation of S2016 was smaller than F2015. One of the reasons that the positive impacts of teaching strategy implemented were not clearly seen, was the major parts of midterm and final exams for S2016 were modified and newly created in order to address the ABET assessment for 4 different outcomes. Accordingly, the exams were more sophisticated than the exams from S2015 and F2015. Furthermore, the final exam scores included the essays, which was 20% of the final exam scores. Accordingly, the impacts of strategies implemented could not be clearly demonstrated.

Fall 2016 midterm and final exam grades were included in order to monitor the impacts of the supplementary teaching strategies. When fall 2016 exam grades were compared with spring 2016 grades, an approximately 4.3% and 5.0% grade improvement were observed for the midterm and final exam grades, respectively. However, the standard deviations overlapped. The results suggested the supplementary teaching strategies, providing midterm and final exam reviews, slightly improved student' exam grades. Table 2 displays the mean and standard deviation of the midterm and final exam grades from spring 2015-fall 2016.

Remark: spring and fall 2016 used the same midterm and final exams, which were different than those of spring and fall 2015.

Table 2 Percentage of mean student scores associated with standard deviation (stdev) for midterm and final exam category

	S2015		F2015		S2016		F2016	
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
Midterm	81.2%	4.8%	81.0%	7%	78.0%	8.5%	81.3%	6.5%
Final	86.1%	6.5%	75.2%	15%	77.7%	1.6%	81.6%	7.1%

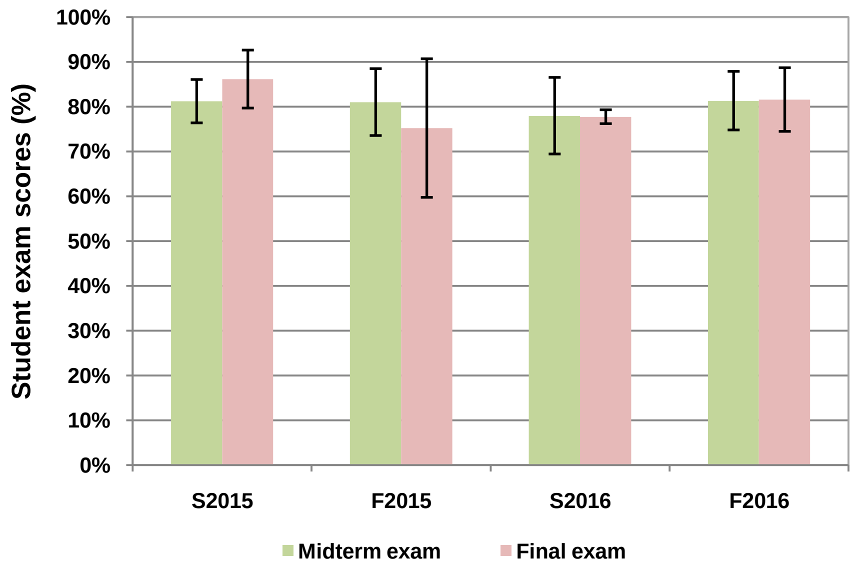

Figure 1 Student midterm and final exam scores rated as percentage between spring 2015 to fall 2016

The student grades for group projects, including presentation, prototypes, term paper are showed in Figure 2. For student presentation and prototype grades, the data from spring and fall 2015 (before strategies utilized) and spring and fall 2016 (strategies carried out), displayed no significant increase of student's grades. Conversely, the student's performance for the term paper category was slight improved from fall 2015 to fall 2016 (77.0±20%, 92.1%±5.7% and 95.1%±3.5 for fall 2015, spring 2016 and fall 2016, respectively) when 90.3%±2.1% was observed in spring 2015. Approximate 19.6% and 23.5% of the term paper scores were substantially improved compared to fall 2015 for spring and fall 2016, respectively. However, the standard deviations overlapped to all score categories from different semesters. This implied the draft submission and draft feedbacks had benefit and could improve term paper grades.

Our overall outcomes demonstrated inconclusive impacts of the implementations. One of the reasons was the midterm and final exams change combined with rubric grading modification prior to ABET. Additionally, student diversity enrolled in this class varied every semester (freshmen to seniors), which may contribute to ambiguous influences of these supplementary teaching strategies. Therefore, for CE101 instruction in the future must apply all the above strategies stated in ***hypothesis 2*** prior to enhancing student's learning performance. Table 3 summarizes percentage of mean student scores associated with standard deviation (stdev) for presentation, prototype and term paper category.

For future work, the author suggested conducting additional analysis for the long-term results, which entailed some analysis without supplementary teaching implementation. Moreover, spring 2015 and fall 2015 data should be eliminated because both utilized different rubrics and exams.

Table 3 Percentage of mean student scores associated with standard deviation (stdev) for presentation, prototype and term paper category

	S2015		F2015		S2016		F2016	
	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
Presentation	87.8%	8.1%	84.7%	5%	86.9%	5.3%	85.9%	7.7%
Prototype	92.3%	8.0%	88.7%	8%	94.8%	5.7%	90.0%	4.1%
Term paper	90.3%	2.1%	77.0%	20%	92.1%	5.7%	95.1%	3.5%

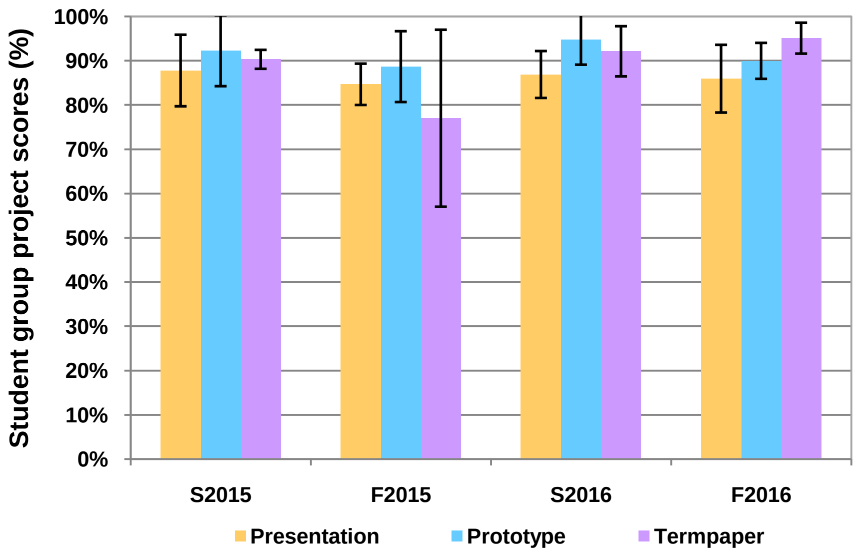

Figure 2 Average student's grades for presentation, prototype, term paper between spring 2015 to fall 2016

Conclusions

To conclude, significant improvement of student's performance before and after supplementary teaching strategies was not clearly observed in exams, presentation and prototype categories. However, approximate 19.6% and 23.5% of the term paper scores were substantially improved compared to fall 2015 for spring and fall 2016, respectively. Several modifications occurred during the study campaign and student diversity may vary the effectiveness of these strategies.

Acknowledgement
This study was supported by the 2015-2016 HSI-STEM grant. The author thanks Dean Tracy Maples and Dr. Jen-Mei Chang for their supports throughout the training and assessment campaigns.

Bibliography

[1] Bradford School of Technical Management, Managerial Skills and Expertise Used by Samples of Engineers in Britain, Australia, Western Canada, Japan, the Netherlands and Norway, University of Bradford, Technical Report TMR 152, Bradford, UK, 1984.
[2] Evers, F., Rush, J., Berdrow, I. (1998) The Bases of Competence: Skills for Lifetime Learning and Employability, Jossey Bass, San Francisco.
[3] Employability Skills Profile: What are Employers Looking For? The Conference Board of Canada, Ottawa, 1993.
[4] Rugarcia, A., Felder, R.M., Woods, D.R., Stice, J.E. (2000). The Future of Engineering Education I: A Vision for a New Century. Chemical Engineering Education 34 (1), 16-25.
[5] Sparkes, JJ. (1989) Quality in Engineering Education. Engineering Professor's Conference, Occasional Paper #1.

[6] Felder, R.M., Woods, D.R., Stice, J.E., Rugarcia, A. (2000). The Future of Engineering Education II: Teaching Methods that Work. Chemical Engineering Education 34 (1), 26-39.
[7] Rangel, B., Guimaraes, A., Vazsa, A., Alves, F. (2016). Integrated Design Concept in Civil Engineering Education. International Journal of Engineering Education 32 (3(A)), 1279–1288.
[8] Mills, J. and Treagust, D.F. (2003). Engineering Education-Is Problem-Based or Project-Based Learning the Answer?, Australasian Journal of Engineering Education, The Australasian Association for Engineering Education Inc, ISSN 1324-5821.