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Final Report

Engaging Engineering Students with Transportation Safety: An Educational Module

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Abstract

In this paper, we will introduce a newly created education module in transportation safety. The module is aimed at undergraduate engineering students, whose exposure to this topic is extremely limited, if they are exposed at all. Topics in the module include driver speed compliance, distracted driving, pedestrian safety, and vulnerable road users (VRUs) with an emphasis on young drivers. The module incorporates a number of items, including lecture material (both instructor and student versions), in-class activity, and laboratory exercises. The learning module is intended to supplement existing courses in engineering curricula. The goal of this learning module is to provide industrial engineering students with current research and knowledge in transportation safety. The module was recently piloted in an undergraduate Industrial Ergonomics courses. Results regarding the effectiveness of the module, as well as results on the student attainment of educational objectives, will be discussed. Finally, suggestions for the modification and inclusion of the material in various industrial engineering courses will be presented.

Chapter 1. Background

Introduction

Active learning has been shown time and again to improve student education (Prince, 2004; Prince & Felder, 2006; Smith, Sheppard, Johnson, & Johnson, 2005). Having students conduct "hands on" activities allows them to comprehend the concepts presented in class on a deeper level. The use of active learning improves student performance as evidenced by test grades, student satisfaction, and retention (Felder, 1995; Felder, Felder, & Dietz, 1998). In the development of new classroom content, it is important to remember that teaching styles that address multiple learning styles are considered to be the most effective for student learning (Felder, 1996; Felder & Brent, 2005; Felder, Felder, & Dietz, 2002). Undergraduate students seek learning experiences that allow them to learn specific tools and techniques that can be used on the job either during a co-op assignment or after graduation.

Within the realm of transportation safety, the need to improve educational approaches for our students is starting to become more apparent. Many existing education-based studies are driven by a desire to satisfy ABET criteria (Keren, Freeman, Harmon, & Bern, 2001), whereas others emphasize the need to improve student comprehension of engineering course material (Weir, 2004). Regardless of the intent, improving engineering education is critical for our students. A number of important challenges exist within the field of engineering education, including retention of students and making upcoming generations interested in engineering (National Science Board, 2007; National Academy of Engineering, 2005). Strategies such as active learning and student engagement are known to be effective solutions to address these challenges, making the development of active course content critical for the future of engineering.

To improve transportation safety in the Southeastern United States, it is critical that we train the next generation of engineers to be concerned with safety and knowledgeable about techniques to improve safety. Whether the engineers go on to work for state departments of transportation, technology firms, manufacturing companies, or service providers, they will all be able to improve transportation safety for themselves and their company. To address these needs, an educational module about transportation safety was developed. For the purpose of this project, a module is a set of materials that can be used in a course. In this project, it consists of one lecture, one in-class activity, and one laboratory activity. The module was developed for undergraduate engineering students (primarily juniors), but could be adapted to other educational levels.

In the following sections, we present information about the objectives and content of the module, as well as student feedback to the module.

The educational module has three primary objectives:

- Increase the number of students exposed to transportation engineering. Through the Industrial Ergonomics course, students will be exposed to transportation safety. It is expected that students who show an interest in the topic will be more likely to pursue transportation related careers or graduate education opportunities.
- Improve the quality of education. The new module, which will be disseminated to other educators, will provide an active, engaging format for presenting content related to transportation safety.
- Improve transportation safety. An ancillary effect of this project will be students who are more safety conscious based on what they learned in the educational module.

Student Learning Objectives

The student learning objectives of the module are critical to measuring its success. After completing the module in a course, students will be able to:

- Describe the impact of safety in terms of physical safety, economics, and productivity.
- Interpret data that explains the importance of transportation safety.
- Understand the need for inclusive design for special populations.
- Understand the impact of individual ability and performance on transportation safety outcomes.
- Interpret guidelines for designing while considering safety, including the Highway Safety Manual.
- Describe how they can use their knowledge and skills to improve transportation safety in their field of study.
- Identify technology (both vehicle and infrastructure) that is designed to improve safety.
- Evaluate the effectiveness of a specific piece of technology with regards to safety.

Chapter 2. Research Approach

Module Development

Module materials were developed in an attempt to provide material that could lead students to accomplish the learning objectives for the project. Four primary sets of material were developed: instructor lecture notes, student lecture notes, in-class activity, and laboratory assignment.

Pilot Testing

To test the module materials, a study was conducted in an undergraduate course, IE 3121/3123 Industrial Ergonomics, a required undergraduate course in the Department of Industrial & Systems Engineering at Mississippi State University. The students took the class during the fall 2012 semester where the lecture material and in-class activities of this module were presented. Additionally, a laboratory exercise was completed. Pre- and post-module questionnaires were conducted to test the effectiveness of the module. Students also took class exams, quizzes, and lab reports post-module to test their ability to apply the educational materials. The questionnaire taken pre- and post-module measured the students' change in interest and perception of transportation safety. The pre- and post-module survey questions are listed in Table 1. A total of 34 students, made up of juniors and seniors (mean age: 21.4), participated in this study. According to the demographics survey there were 24 males and 8 females, and 13 seniors and 19 juniors.

Table 1. Perception survey items

Number	Content
1	Transportation safety is a topic that is important to me.
2	Transportation safety is an important topic for society.
3	Transportation safety is useful in my field of study
4	I am interested in learning more about transportation safety.
5	People in my career field need to know about transportation safety.
6	People in other career fields need to know about transportation safety.

Revision and Validation

The module materials were then revised based on the pilot study results. The revised material was validated in a second course. The validation study was conducted in an undergraduate course, IE 3121/3123 Industrial Ergonomics, a required undergraduate course in the Department of Industrial & Systems Engineering at Mississippi State University. The students took the class during the fall 2013 semester where the lecture material and in-class activities of this module were presented. Additionally, a laboratory exercise was completed. Pre- and post-module questionnaires were conducted to test the effectiveness of the revised module.

Chapter 3. Findings and Applications

Module Materials

The module is intended to supplement existing courses in engineering curricula. The module includes lecture material (instructor and student versions, class time estimate: 45 minutes), in-class activity (instructions and material, class time estimate: 15 minutes), and laboratory exercises (instructor material for the setup of the laboratory exercise, as well as student materials for the completion of the laboratory exercise, class time estimate: 2 hours). Complete module materials are posted online at http://ergo.research.ise.msstate.edu/stride-classroom-module/.

Lecture

The lecture material is intended to provide students with an overview of the field of transportation safety, its scope, and its importance. The lecture material includes the following topics:

- The field of transportation safety – scope and terminology definitions
- Overview of transportation safety data – current trends, sources of data, and interpretation
- The impact of individual ability and performance on transportation safety, with examples from driver speed compliance, distracted driving, and pedestrian safety
- The importance of special populations and inclusive design, with a focus on vulnerable road users and young drivers
- The application of a student's own knowledge and skills to improve transportation safety in their own field of study, with various application areas and engineering fields.

Both instructor and student versions of the lecture material were created. An example slide from the lecture material is shown in Figure 1.

Figure 1. Example lecture slide

In-class Activity

In the class activity, students view a short video in which a pedestrian in a crosswalk is very nearly hit by a vehicle. The class is divided into four groups (A, B, C, and D), and discusses the scenarios shown in Figures 2 and 3. The first two scenarios (Figure 2) emphasize performance measures through a distraction example. The second set of scenarios (Figure 3) emphasizes user differences through an age example. All scenarios are presumed to take place in the same environment and conditions viewed on the near-miss video.

Figure 2. In-class activity scenarios for groups A and B

Figure 3. In-class activity scenarios for groups C and D

Laboratory Assignment

The laboratory assignment allows students to explore various techniques and interventions for improving transportation safety. In the lab, the instructor first presents some information on various types of interventions, with examples, case studies, or videos for each

(Figure 4). The students then work in groups to complete a laboratory assignment. In groups, the students:

- Identify a transportation safety topic of interest, and locate a statistic that describes the importance of the topic
- Identify current guidelines in place that addresses that topic
- Evaluate an intervention currently in place in town that is trying to improve the safety based on the chosen statistic – show documentation of the intervention, and discuss whether the intervention is effective
- Design three interventions to improve your transportation safety statistic, including one each for infrastructure, vehicle, and training
- For each design, discuss how it would improve the data and any drawbacks to incorporating the changes.

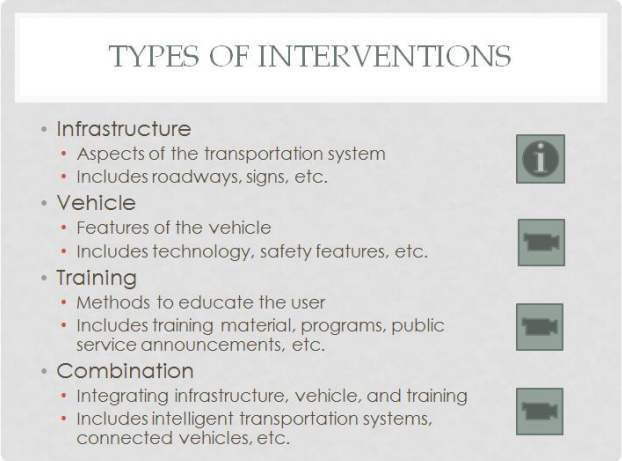

Figure 4. Example material from laboratory assignment

Student Results

Survey Questions

The participants' mean responses to the pre-module survey and post-module survey were calculated. A comparison of these means with the calculated standard error is shown in Figure 5. Responses to the post-module survey were further evaluated according to gender shown in Figure 6.

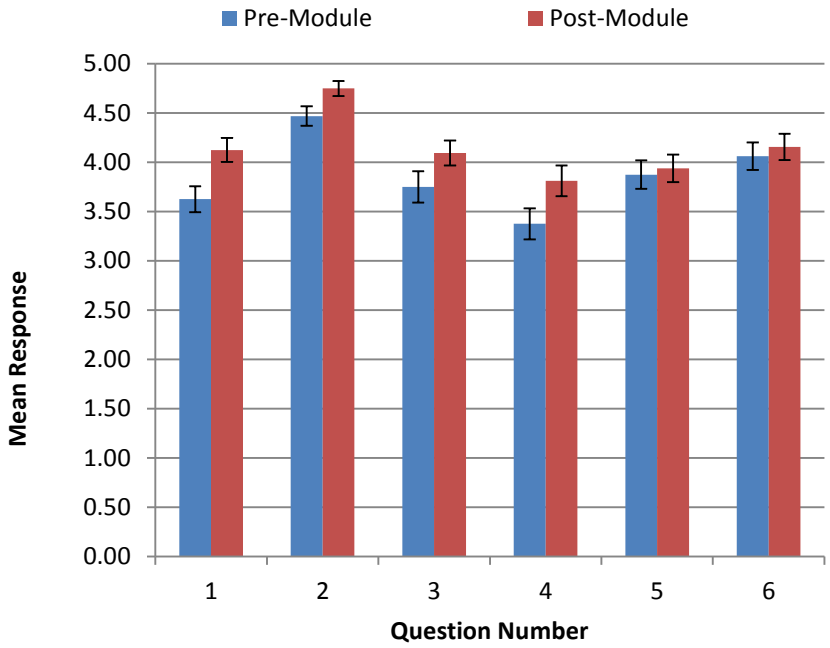

Figure 5. Comparison of mean responses on pre-and post-module questionnaires

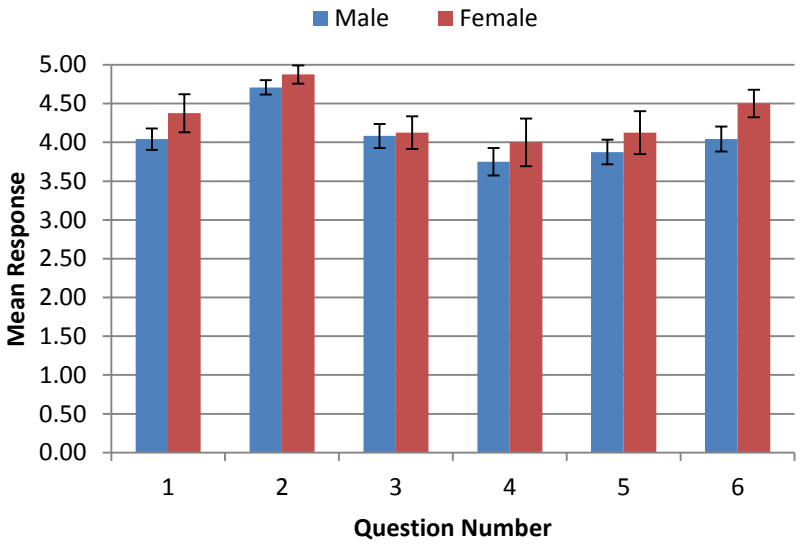

Figure 6. Comparison of mean responses on post-module questionnaire based on gender

Significance between pre- and post-mean responses was tested using a paired-t test for each of the six questions. There were significant differences for the first four questions. The following paragraph reports the mean (M), standard deviation (SD), and sample size (n) for each question, along with inferential statistical results.

There was a significant difference in the pre-module (M=3.625; SD=0.751; n=34) and post-module (M=4.125; SD=0.707; n=37) responses to question 1, which inquired about the personal importance of transportation safety; t(31)= -3.52, p = 0.001. There was also a significant difference in the pre-module (M=4.469; SD=0.567; n=34) and post-module (M=4.750; SD=0.440; n=37) responses to question 2, which asked about the importance of transportation safety in society; t(31)= -2.51, p = 0.018. Question 3 examined the usefulness of transportation safety within the students' field of study. There was a significant difference in the pre-module (M=3.750; SD=0.916; n=34) and post-module (M=4.094; SD=0.734; n=37) responses to question 3; t(31)= -2.61, p = 0.014. There was also a significant difference in the pre-module (M=3.375; SD=0.907; n=34) and post-module (M=3.813; SD=0.896; n=37) responses to question 4, which inquired about the interest in learning more about transportation safety; t(31)= -3.09, p = 0.004.

Questions 5 and 6, which asked about the need for people in both the students' field of study and elsewhere to be knowledgeable of transportation safety, did not increase significantly post-module. Likewise, there was no significant difference in mean responses to any of the questions, based on gender.

Exam Results

On the students' third exam in the course (taken after the lecture material and in-class activity), there were 2 questions referring to transportation safety. The average grade for those questions was 71.56 and 79.69 respectively, out of a possible 100 points. The final exam (taken after the laboratory assignment and all other module activity was finished) also contained a multi-part question concerning transportation safety. The average grade for this question was 94.79 out of a possible 100.

Perceptions of Module

Feedback for improvements on the lecture, in-class activity, and lab activity were obtained via open-ended questions.

In the lecture, the students enjoyed learning new information about different types of transportation accidents and their statistics as well as the video depicting a real world accident situation. Some suggestions for improvement include adding more visual aids and allotting more time to fully understand the magnitude of the statistics.

According to student responses the in-class activity was well prepared. The ability to collaborate in groups and brainstorm individual solutions to the real world problem presented in the video was the most positive aspect of the activity. However, some suggested using smaller groups for better communication and requested a greater variety of situations to assess.

The lab activity resembled the in-class activity but with greater freedom to choose a local transportation problem and creative solutions. The students enjoyed this freedom; however, a

few reported they would have preferred more guidelines to direct their creativity. Another suggestion which sounded interesting was to have a presentation from each group instead of turning in a lab report. This would allow the students to see the other creative solutions their peers generated.

Validation Results

Validation results from the student survey are shown in Figure 7. While there were no significant differences between pre- and post-module results, five of the six survey questions saw an increase in student ratings.

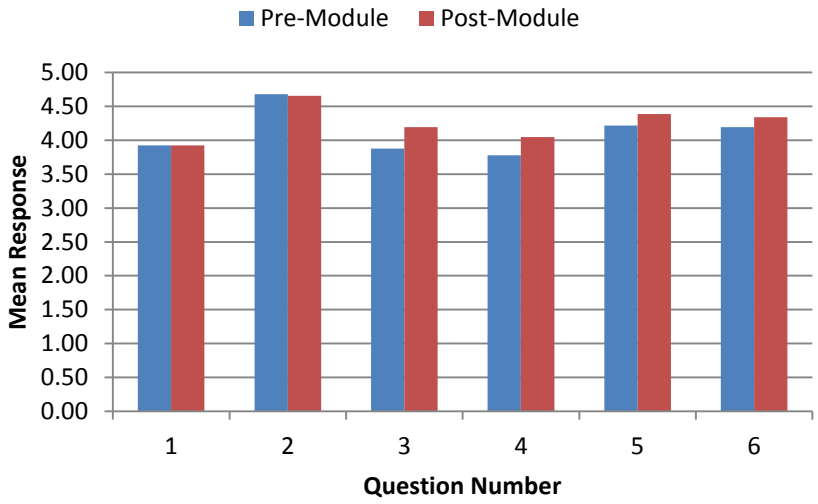

Figure 7. Survey responses from module validation

A comparison of survey responses (post-module) between the two module versions is shown in Table 2. The revised module received better student ratings than the initial module on questions 3-6, and lower student ratings on questions 1-2.

Table 2. Comparison of survey responses before and after module revision

Survey Question	Version 1 Post-Module Average	Version 2 Post-Module Average	Change
1	4.11	3.93	-0.18
2	4.76	4.66	-0.10
3	4.08	4.20	0.12
4	3.81	4.05	0.24
5	3.97	4.39	0.42
6	4.16	4.34	0.18
Overall	4.15	4.26	0.11

Chapter 4. Conclusions

Students' perception of the importance of transportation to themselves and society increased significantly post-module. The module also increased their interest in learning more about transportation safety as well as its perceived usefulness in their field of study. Thus, the module proved to be successful in raising knowledge and awareness of transportation safety. Additional positive effects of the module can be seen in the exam scores. Exam 3 was taken pre-lab activity and the final exam was taken after completing the lab. There was a sizeable increase in the mean scores between those exams. Therefore the module also increased the students' ability to apply the information they received on transportation safety.

The revised module showed significant improvement in the scores on both questions 5 and 6. Major revisions included a decrease in the number of statistics presented, changing the format of the laboratory deliverable to a presentation rather than a written report, and spending more time discussing the use of various design principles in transportation safety. The student ratings scores decreased on questions 1 and 2, likely due to the increase in career-specific information, and reduction in society-general information about transportation safety.

The study objective was met. Both the exam results and questionnaire results showed that students were able to interpret data and understand the importance of transportation safety after the learning module. In addition, students learned how to apply their knowledge in improving transportation safety in their field.

It is recommended that other faculty incorporate this module in their courses. Future research on the effectiveness of the module in other disciplines could be pursued. Additional course modules on specific transportation safety topics could also be developed.

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