

Redesigning the Transportation Course to Incorporate Team-Oriented, Project-Based Field Assignments

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Abstract

Part of a continuous improvement process, the Civil Engineering Technology (CET) Department at the University of Pittsburgh at Johnstown has reviewed its 4-year program curriculum to ensure that the curriculum not only meets accreditation requirements, but also meets the demands of the industry. As a result of the review process, the transportation course became a required course at the junior level for all civil engineering technology students. The course credit hours were increased to 4 semester credit hours to allow for developing a laboratory component for the course.

The use of lab assignments in the transportation course allowed students to get hands-on experience and training in conducting transportation studies utilizing the latest standards employed in the industry. The lab also enabled the instructor to use open-ended problems such that members of each team can search for feasible solutions that meet specific guidelines. Different teams may end up with different analysis results or design solutions. Feedback from students indicated their appreciation for integrating the lab assignments into the course.

This paper describes the pedagogical aspects of redesigning the transportation course and the positive impact it had on teaching the course and on the CET curriculum. The course outcomes and the components of the lab assignments are presented and discussed. Feedback from students is also analyzed and discussed. The experience gained from the process of redesigning the course may provide useful guidance to those considering ways to develop a course in transportation that meets both ABET criteria and industry demands.

Introduction

The University of Pittsburgh at Johnstown offers a 4-year B.S. degree in Civil Engineering Technology (CET). The program has five areas of concentration: Construction, Environmental, Management, Structural / Foundation, and Transportation. The curriculum of at least one of the concentration areas must be completed in order for a student to graduate from the program. The current curriculum for students electing to concentrate on Transportation includes three required courses: Elementary Surveying, Civil Computations (computer applications of surveying), and Transportation. In addition, students focusing on transportation are expected to take two more courses offered to students as technical electives: Highway Surveying and Design and Pavement Design and Management. A CET graduate with concentration in the area of transportation is likely to be involved in one or more of the five major areas: planning, design (geometric and pavement), construction, operation, and maintenance of transportation facilities.

Transportation (CET-1123) is currently the required course at the junior level replacing the technical elective Highway Surveying and Design. The course credit hours were increased to 4 semester credit hours to allow for developing a laboratory component for the course. This change was a result of a program and curriculum review process. Meeting with members of the engineering technology division Industry Advisory Committee (IAC) regarding the curriculum review resulted in recommendation to make transportation the required course. The proposed changes were discussed and approved at both the CET department and college levels.

The transportation course has design and problem solving components. It develops students' ability to use mathematical formulas, specifications and guidelines by design agencies, assumptions and finally common sense to recommend solutions for a given transportation problem.

Accreditation Board for Engineering and Technology (ABET) outlines the Engineering Technology (ET) and Civil Engineering Technology Program Criteria for accreditation. ⁽¹⁾ The addition of the lab component was a step to make the course as a whole able to meet the new program accreditation requirements as follows:

ABET general criterion: An ET program must demonstrate that graduates have:

- an appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines (criterion **a**).
- an ability to conduct, analyze and interpret experiments and apply experimental results to improve processes (criterion **c**).
- an ability to function effectively on teams (criterion **e**).
- an ability to identify, analyze and solve technical problems (criterion **f**),
- an ability to communicate effectively (criterion **g**),
- a recognition of the need for, and an ability to engage in lifelong learning (criterion **h**),
- an ability to understand professional, ethical and social responsibilities (criterion **i**),
- a respect for diversity and a knowledge of contemporary professional, societal and global issues (criterion **j**).

In addition, CET program specific requirements that the course should be meeting include that graduates be capable of:

- employing productivity software to solve technical problems (criterion **f**).
- applying basic technical concepts to the solution of civil problems involving hydraulics, hydrology, geotechnics, structures, material behavior, transportation systems, and water and wastewater systems (**d**).
- performing standard analysis and design in at least three of the recognized technical specialties within civil engineering technology that are appropriate to the goals of the program (**e**).

Redesigning the transportation course is a step to help achieve the above mentioned ABET accreditation criteria as will be discussed further in the following section. The course changes will also support the division Strategic Goal 1: Engineering Technology (ET) will offer students a high-quality undergraduate education that constructs a bridge between theory and application and includes sensitivity to the needs for others through the study of liberal arts and science. ⁽²⁾

In a previous year, the author worked on re-designing the transportation course to be more inclusive in terms of diversity⁽³⁾. The initiative was in response to a UPJ diversity statement urging faculty to find opportunities within the curriculum to address diversity. Transforming the course to be more inclusive was found to help achieve ABET accreditation criteria (j) mentioned above.

Implementation

The re-designed transportation course was offered to students for the first time in fall 2004. On the first day of classes, the course requirements were discussed along with the course syllabus. The syllabus outlined the course description, expectations, grading system, lecture and lab schedules, and course outcomes. A number of references have been given to students along with a selected textbook. Students also get handouts for a number of topics because some recent publications are only available in papers, reports and other textbooks.

The redesign process involved two components. The first component was expanding the course content, based on feedback from industry to include topics on current issues. As given in the syllabus, the topics that were added were:

- Transportation Systems Management (TSM)
- Intelligence Transportation Systems (ITS)
- Vehicular emissions of air pollutants
- Noise generation and measures
- Energy consumption

The second component involved developing team-oriented, project based lab assignments to aid in the analysis and design of transportation facilities. The lab component was fully integrated into the course through a series of assignments. Each assignment included tasks that could be completed in one or two weeks. Project activities included field data collection using manual methods and special devices, data analysis and presentation using analysis and design software, and writing reports.

Cooperative learning was used as the instruction style in the lab. Cooperative learning is defined as instruction that involves working in teams to accomplish an assigned task and produce a final product, under conditions that include the elements: *Positive Interdependence, Individual Accountability, Face-to-Face Promotive Interaction, Appropriate Use of Teamwork Skills, and Regular Self-assessment of Team Functioning*.⁽⁴⁾

The term “Team” is used here and not “Group” because in teamwork, activities span over a long time (weeks, a whole semester) while activities span over a short time frame for group work. Also, teams are formed carefully while groups are formed spontaneously.⁽⁵⁾ The students worked in teams of three or four and were carefully formed by the instructor.

At the beginning of the semester, students were asked to fill out a student data sheet in which they provided information about their technical background and experiences inside and outside of school as well as their interests. The student data sheet provided feedback on each student's prior learning to help determine the "starting" point of instruction. ⁽⁶⁾ The student data sheet also included information that would help the instructor in team formation.

One provision of team formation was for each student to identify a student with whom he/she would like to work and one student with whom he/she would prefer not to be teamed with. Students were told that their choices would be taken into consideration but were not guaranteed because of feasibility problems such as the case when many students name one student whom they wish to work with. Another consideration was that students with a background or experience in transportation studies were distributed over the groups such that the few students who have a good background in transportation studies from summer internships or part time jobs did not end up in the same team.

The lab assignments were designed so that they could be completed in one or two weeks. The requirements of each assignment was outlined and given to students as a handout. General lab objectives included:

- successful teamwork.
- improving presentation and communication skills.
- improving writing and lab preparation skills.
- hands on experience on how to conduct transportation studies including data collection, data analysis, developing design alternatives, and presenting project findings.
- utilizing HCS software in analysis and design of transportation facilities.

Following is a summary of Lab activities:

- The students worked in teams of three or four.
- A handout was designed to outline the requirements of each assignment.
- The lab assignment was completed in one or two weeks.
- The requirements were mixed between being general (open-ended) and specific to allow each team to search for feasible solutions that meet lab requirements.
- Different teams could end up with different solutions.
- The instructor approached each team and discussed with the team members their solutions and possible alternatives.
- Students were challenged to think and search for answers but yet given sources of information that will help them find such answers.
- Students were encouraged to think about the logic behind their choices.

New equipment was specifically purchased in order to be utilized in the lab. The equipment included traffic counters and a speed radar gun. Students were given the opportunity to utilize a program called Highway Capacity Software (HCS). The program aided in the traffic analysis and design of highway facilities. The software was purchased to allow for hands on training. Students would first carry out the design or analysis tasks manually to fully understand the process then they employ the HCS software to verify their manual work and carry out sensitivity analysis.

When the meeting with students was scheduled for computer applications using the HCS, students met in the computer lab. The capacity of the lab was limited to 20 to allow for full interaction between students and the instructor to ensure that students follow the instructions correctly. The use of the software was presented to students through an active session using real examples. The presentation followed a carefully planned outline, with built-in questions and side notes to stimulate class discussions as well as to motivate students' interests. Each student was required to get access to the software and to work out analysis and design examples in a step-by-step approach along with the instructor.

Grading student performance and teamwork was done such that individual accountability was considered in the grading. With each submission, students were asked to fill a sheet to report on the rating of each team member with respect to the degree to which each member has fulfilled his/her responsibilities in completing the lab assignment. ⁽⁷⁾

Feedback from Students

A questionnaire was administered at the end of the semester to obtain feedback from students on the usefulness of the lab as a required part of the course. The questionnaire consisted of 17 questions. In 13 questions, the answer format was multiple-choice such that the range of responses was from "1" meaning "Definitely No" to "5" meaning "Definitely Yes". The transportation class consisted of 21 juniors, 18 were in attendance and filled the questionnaire.

Table 1 presents the student responses with respect to their opinions on the usefulness of the lab component of the course. The percent of maximum score and average student response have been used to quantify the response by students to these questions as shown in Table 1. The maximum score is the number when all students select "Definitely Yes" which has a value of five (5) as their response in favor of the idea (i.e. maximum score = 100 for a class of 20 students). The range of responses is from "1" meaning "Definitely No" to "5" meaning "Definitely Yes".

The following comments can be made on Table 1:

- The majority of students (score 4.5 out of 5) indicated that the lab was a valuable component of this course. They also indicated that there was a good coordination between the lecture and the lab.
- As stated earlier, the instructor prepared a handout for each lab to help the students understand the requirements and procedure involved. Most students indicated that the lab handouts were clear and helpful in conducting each study. They also indicated that the breakdown of each lab activities was logical and allowed each project to be completed as scheduled.
- Almost all students (score = 4.8) thought that using equipment like the radar gun and traffic counters was educational and fun. The equipment used so far has been specifically purchased for the lab. They were not expensive and were worth buying as they appeared to have a very positive impact on the lab experience for students.

Table 1: Student Responses to questions on usefulness of the new lab

No.	Question	Response	
		% Of Maximum Score (Max=100)	Average (5 for strongly agree)
Q1	The lab was a valuable component of this course	93.3	4.7
Q2	There was a good coordination between the lecture and the lab	90.0	4.5
Q3	Lab handouts were clear and helpful in conducting each study	88.9	4.4
Q4	The breakdown of each lab activities was logical and allowed the project to be completed as scheduled	86.7	4.3
Q5	Using equipment like the radar gun and traffic counters was educational and fun	96.7	4.8
Q6	Working in teams was challenging but important	95.6	4.8
Q7	The lab helped me become a better team player	83.3	4.2
Q8	Presenting the traffic accident study was helpful in improving my presentation and public speaking skills	85.6	4.3
Q9	The instructor encouraged students to ask him questions and he was helpful in making sure the lab is done properly.	94.4	4.7
Q10	The demonstration on using HCS Software in analysis and design was a good idea and helpful	92.2	4.6
Q11	Writing formal reports in this lab helped me improve my writing and my report preparation skills	86.7	4.3
Q12	The lab encouraged using the internet and visiting professional web sites	74.4	3.7
Q13	The lab prepared me to be able to conduct real world studies in transportation	94.4	4.7

- Improving the ability of students to work in teams has been one of the main objectives of the lab. Most students (score = 4.8) acknowledged the challenge involved in teamwork, but agreed that teamwork is vital for the successful completion of civil engineering projects. A smaller percentage yet still a relatively high score (4.2) felt that the lab helped them become better team players. Obviously becoming a good team player is a process that would take years of practice in working in teams. This lab is a step in this direction.
- One lab (traffic accident studies) required students to present their study findings using PowerPoint and team presentation of the work. Many students (score = 4.3) felt that this practice was helpful in improving their presentation and public speaking skills.

- Again, almost all students agreed that the instructor encouraged them to ask him questions and that he was helpful in making sure the lab is done properly. This indicates a strong correlation between students' satisfaction and instructor's involvement and effectiveness.
- Two of the lab topics required students to utilize the Highway Capacity Software (HCS) in the analysis and design of a highway facility. This software was purchased specifically for this lab. Again, almost all students (score = 4.6) found the demonstration on using the HCS software in analysis and design to be a good idea and helpful in understanding the concepts involved.
- With a score of 4.3, it is evident that the writing component of the lab helped students improve their writing and their report preparation skills. The lab required students to submit formal reports for over half of the experiments.
- The lab encouraged using the internet and visiting professional web sites. It appears that the lab can be improved to do a better job in this area since the score was 3.7 which was relatively lower than most other scores. Currently, only one lab assignment required students to navigate the Internet and visit professional web sites but there is room available in other lab assignments for this requirement.
- The vast majority of students (score = 4.7) strongly agreed that the lab prepared them to be able to conduct real world studies in transportation, the main objective of the lab.

Question 14 in the questionnaire asked students to list the best things about the lab. Following are excerpts from the comments made by students.

- *“Working as a team”*
- *“Incorporation of theory from class and real hands-on practice of the lab”*
- *“Helped me write reports and give presentations”*
- *“Getting out into the field and doing hands on data collection”*
- *“Helped to combine the real world with the theoretical models and equations we use in class”*
- *“Observed many different aspects of transportation”*
- *“Learning hands-on where transportation data comes from, how to conduct studies”*
- *“Radar gun and electronic traffic counters”*

Question 15 in the questionnaire asked students how the lab can be improved. Following are excerpts from the comments made by students.

- *“Less formal lab write-ups (they take a lot of time)”*
- *“Possibly more oral presentations like the accident study”*
- *“More equipment”*
- *“Visits to transportation consulting firms”*
- *“Allow more time for collecting data due to conflicting group member schedules”*
- *“finding time to do the lab was difficult”*

The instructor will take all the comments seriously and will be making some changes next year in consideration of the comments made. For example, a project manager in a local consulting firm has been invited to speak to the class of next year about professional transportation projects.

Question 16 in the questionnaire asked students to list the software they have used in this lab (Word, Excel, PowerPoint, AutoCAD, HCS, MathCAD ...etc). The responses are displayed in Figure 1.

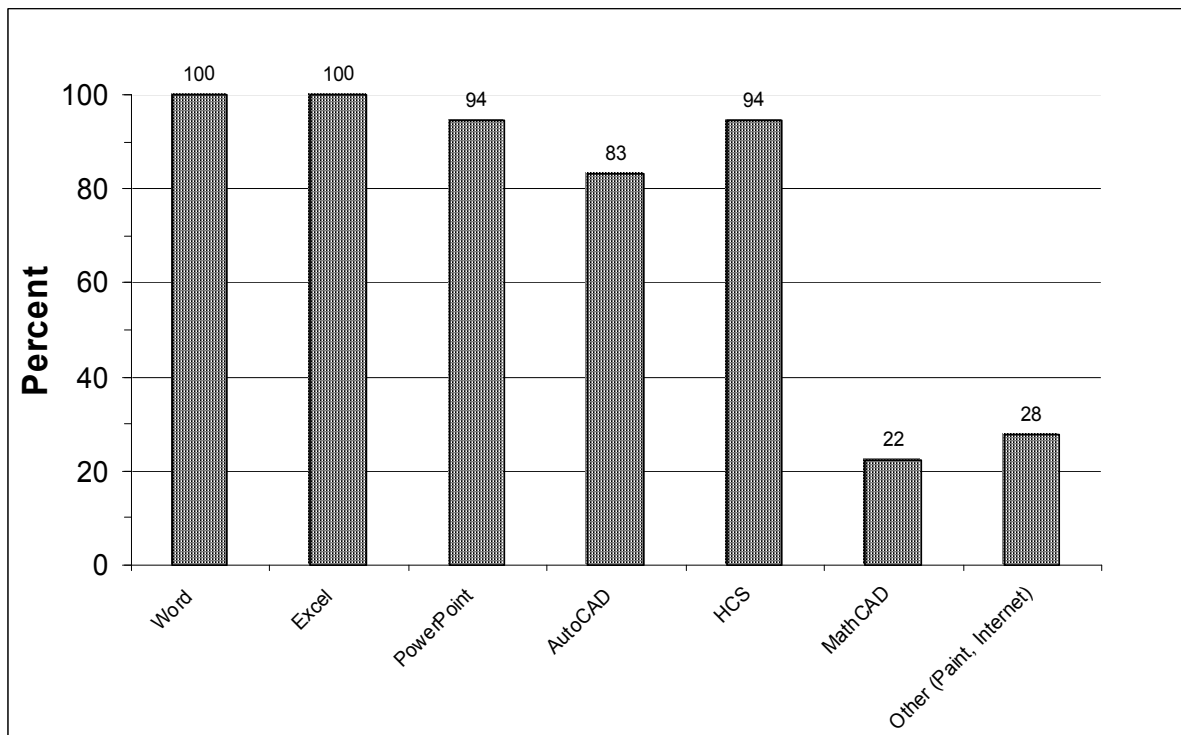


Figure 1: Student Responses to the question on software use

Students clearly indicated using at least 5 computer programs to successfully meet the lab requirements. All reports had to be typed in Word. Excel was used extensively in almost all reports for data analysis including statistics. Students used PowerPoint for the accident study presentation. The use of AutoCAD was not mandatory but most students used it to draw parking layouts to scale. The use of the Highway Capacity Software (HCS) was required for two lab topics. Some students decided to use MathCAD and other programs to enhance the accuracy and appearance of their reports.

Finally, students were asked to provide any additional comments. Following are excerpts from the comments made by students.

- *“The lab material really helped me to understand the full aspects of the material presented in class”*
- *“Liked the group grading sheets”*
- *“Lab was fun compared to others I’ve had. Reports were challenging to say the least”*
- *“I think the lab is important and also fun”*

Summary and Conclusions

The transportation course was re-designed to help the CET program not only meet accreditation requirements, but also meet the demands of the industry. The redesign process involved two components. The first component was expanding the course content, based on feedback from industry, to include topics on current issues. The second component involved developing team-oriented, project based lab assignments to aid in the analysis and design of transportation facilities.

The development of the lab allowed for open-ended design and analysis requirements that enable students to search for feasible solutions that meet certain guidelines. The use of lab assignments in the transportation course allowed students to get hands-on experience and training in conducting transportation studies utilizing the latest standards employed in the industry. The development of the lab also supported the college strategic goals and objectives and helped in meeting ABET accreditation requirements.

The lab was taught in a cooperative learning environment that involved having students work in teams to accomplish the assigned tasks. Almost all students in this class expressed appreciation for developing the lab components, endorsing the opportunity provided for hands-on experiences and teamwork.

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