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Use Of Ongoing Assessment Of Intended Learning Outcomes To Evaluate Effectiveness Of Online And On Campus Delivery Of A Structural Analysis Course

Abi Aghayere
Rochester Institute of Technology

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Abi Aghayere
College of Applied Science and Technology
Rochester Institute of Technology

Abstract

The ABET TC2K criteria now require proof of continuous improvement similar to the quality assurance programs, such as, the Continuous Quality Improvement (CQI) that have long been used in industry. In order to effect continuous improvement in a program or course, ABET requires documentation of the procedure for assessing the course or program, a determination of any areas of weakness, effecting necessary changes to improve the course and then, re-assessing to find out how well the adopted measures worked, thus "closing the loop" on the continuous improvement process.

The Civil Engineering Technology (CET) program at Rochester Institute of Technology (RIT) is preparing for an ABET accreditation next fall. In preparation for the accreditation visit, the author carried out a survey of students in the online and on-campus structural analysis courses to gauge how well the predetermined set of intended learning outcomes (ILOs) were achieved. The students were asked to rate the ILOs for each of the six modules in the course on a scale of 1 to 5 (5 being "very well understood" and 1 being "not understood at all"). The students submit the survey for each module at the completion of each module, thus providing immediate and on-going feedback on student learning that could be used to make mid-course corrections. This paper discusses the results obtained from this assessment, if differences in student learning exist between the online and on-campus sections, and identifies potential areas of improvement.

Introduction

The ABET TC2K accreditation process has shifted from mere "bean counting" to a focus on outcomes assessment and continuous improvement. There are several course assessment methods available in the literature [1, 2, 3] but one commonly used method is the student survey of course objectives; this method is used in this study. To assist the CET program at RIT measure the effectiveness of its online and on-campus delivery of courses, a pilot study was conducted that consisted of an on-going survey of students in both the online and on-campus sections of the Structural Analysis course. The course is divided into seven modules, each with its own set of detailed Intended Learning Outcomes (ILOs). The students were required to rate how well they achieved each ILO using five-point scale, with "least understood" corresponding to 1 and "very well understood" corresponding to 5. The feedback from the student surveys was used to assess the need for any mid-course corrections and to assess the course delivery methods; it was also used to determine the students who were in need of extra help on a particular topic. In addition

to the rating the module ILO's, students were also required to rate how well the overall course objectives were achieved.

The Structural Analysis course is a 4-credit hour course offered to 4th year CET students and online students enrolled in the Structural Design Certificate program at RIT. For the fall quarter of 2003 in which the surveys were conducted, there were 37 students enrolled in the on-campus section of the course and 5 students enrolled in the online section.

The course delivery method for the on-campus section consists of four 50-minute lectures each week for ten weeks and includes weekly homework assignments carried out in groups of four students. Each student is required to complete every assignment individually before meeting with their group to decide on the best solution that will be submitted. To enable students acquire some hands-on learning experience, a group structural analysis laboratory project using the ANEX small-scale laboratory is also assigned. The main text used in the course is a 230-page set of concise and practice-oriented course notes developed by the author. This is augmented by a published structural analysis text, though student evaluation comments indicate that they overwhelmingly prefer and learn better with the developed course notes. The transparencies of these course notes are used by the instructor in the face-to-face lectures.

The online course delivery is entirely web-based and delivered asynchronously using myCourses, an RIT variation of the Prometheus Course Management software. myCourses features the following sections: Syllabus section, Grade Book, Messages, Files, Discussions, and Utilities. Weekly homework assignments are completed individually by the online students, and the same course notes that are handed out to the on-campus students are mailed to the online students. In addition, the online students complete an internet research and a report on a structural failure case study in lieu of the structural analysis laboratory experiment completed by the on-campus students.

Currently, all on-campus courses at RIT also use the myCourses software, though the extent to which the website is used for on-campus classes depends to a large extent on the individual faculty member. In my on-campus structural analysis class, all features of myCourses are used similar to the online section of the course. The Discussion Forums are the most highly visited area of myCourses with a lot of student-to-student and student-instructor interaction taking place. The only major difference in the delivery of the online and on-campus sections of the Structural Analysis course is the absence of the face-to-face interaction in the online section. It is also noteworthy that all of the online students work fulltime and are only able to devote evenings and weekends to learning the course materials.

Course Modules

The course is divided into seven modules, each with its own ILOs and a typical survey instrument for the course modules and overall course objectives are shown in Appendix 1. The course modules serve as a road map to guide the students to enable them to track their progress in the course. In addition to rating the ILOs in each course module, the students are also required at the end of the course to rate the Overall Course Learning Objectives.

With the on-going survey of these ILOs, the instructor is able to detect areas of weakness that a particular student may have in a particular topic, and thus be able to address that weakness speedily by providing extra tutoring help to the student. Any student with a rating of 2 or less in an ILO is usually provided with extra tutoring. For on-campus students, the extra tutoring help is usually given one-on-one in the instructor's office, while for the online students, the extra tutorial is done over the phone during the weekends.

Student Survey Results

The survey result for each student for each module was entered into a spreadsheet to determine the average rating for each module for each student. The average rating for each ILO in each module for the online and on-campus sections of the course are shown in Table 1. Out of a total of 37 students enrolled in the on-campus section of the course, about 34 students consistently returned their surveys. For the online section, 4 out of the 5 students enrolled in the course returned their surveys.

The average module rating was higher for the online section compared to the on-campus section of the course in modules 1, 2, 4 and 5. For modules 3, 6 and 7, the on-campus section of the course was rated higher. The highest rated module was module 1 with an average rating of 4.62 while the lowest rated module was module 6 with a rating of 3.67. This lower rating for module 6 may indicate the problem students traditionally have with understanding the concept of influence lines which deals with the effect of moving loads on a structure, as opposed to static loads. The overall average rating for all modules was 4.0 for the on-campus class and 4.19 from the on-line section. From a statistical significance t-test[4], the calculated t- value of 1.38 is less than the tabulated t- value corresponding to a degree of freedom, df of 14 and an alpha level $p < .05$. The number of students with an ILO rating of 2 or less, indicating a need for extra tutoring, was a maximum of 5 per module for the on-campus section of the course and a maximum of 2 per module for the online section of the course.

Table 1. Average Module Ratings

Modules	Topics	Average Module Rating		Number of Students with ILO Rating of 2 or less	
		On-campus	Online	On-campus	Online
Module 1	Structural loads; structural elements; gravity load support structural systems; load paths; statical determinacy	**4.24**	**4.62**	**3**	**0**
Module 2	Statics and equilibrium; beam reactions; shear wall analysis	**3.85**	**4.38**	**5**	**1**
Module 3	Statical determinacy of trusses; method of joints and method of sections for truss analysis; loads on trusses	**3.89**	**3.86**	**0**	**2**
Module 4	Free body diagrams; internal forces in beams and frames; bending moment and shear force diagrams; computer aided analysis; approximate deflected shapes	**3.98**	**4.29**	**2**	**0**
Module 5	Cables and Arches	**4.12**	**4.57**	**0**	**0**
Module 6	Influence lines	**3.99**	**3.67**	**0**	**1**
Module 7	Approximate methods of analysis for beams and frames under gravity and lateral loads; moment distribution and introduction to matrix methods of analysis	**4.0**	**3.93**	**0**	**0**
Overall Course Objectives (Module #8)	Overall Course Objectives	**3.96**	**4.2**	**N/A**	**N/A**
Mean of all 8 Modules		**4.0**	**4.19**		
Standard Deviation		**0.1246**	**0.3428**		
Variance		**0.01553**	**0.1175**		

$t = 1.38$, $df = 14$, $p < .05$

Summary and Conclusions

The author has carried out a survey of students in the online and on-campus sections of a structural analysis course to determine the extent to which the ILOs are achieved. The only major difference between the online and on-campus sections of the course is the absence of face-to-face interaction in the online section.

The average rating for all modules was within the same ballpark for both the online and on-campus sections of the course. The survey results did not indicate any significant differences in student learning between the on-campus and online sections of the course. The statistical significance t-test result lends support to this conclusion. This would seem to imply that the absence of face-to-face interaction in the online section and the fact that online students work fulltime, and are only able to devote evenings and weekends to learning the course materials did not appear to be a significant disadvantage for this set of online students. It should be noted that many online students are professionals and are typically more mature than the average on-campus student; as a result, they are usually more self-motivated to learn than their on-campus counterparts. This could explain the reason for their higher rating.

The lowest average module rating was 3.67 and the highest rating was 4.62, which indicates successful delivery of both the online and on-campus sections of the course. Based on an average overall course objective rating of 3.96 and 4.2, respectively, for the on-campus and online sections, respectively, we can conclude that the course objectives for this course were achieved. The above conclusions were also confirmed by the students' performance in the course as indicated by the final grades. All the students in the online section and all but one student in the on-campus section passed the course; the average grade for both the online and on-campus sections of the course was C+ or an average grade point of around 2.43.

Using the course module ratings, the instructor was able to identify students who needed extra help; students with an ILO rating of 2 or less were invited to the instructor's office for extra tutoring. Extra tutoring for online students with a rating of 2 or less was done over the phone during the weekends. It is this author's belief that online student learning was enhanced in this course by the telephone interaction between the instructor and the online students, in addition to e-mail correspondence and frequent postings on the Discussion Forums. Calling online students on the weekends to provide tutoring sessions encourages them and makes them feel that the instructor cares. It also minimizes the feeling of isolation that some online students may have.

The use of ongoing feedback, as opposed to using just the end-of-quarter student evaluations, is useful in making mid-course corrections and providing immediate and useful help to students who might be struggling in a particular area of the course. This ensures that the students benefit during the course, resulting in increase learning, rather than waiting for the end-of-quarter course evaluations to find out how much or how little they learned in the course. The author recommends that on-going assessment of course objectives and intended learning outcomes (ILO's) be used in ET courses, in addition to end-of-quarter student evaluations, to enhance student learning and faculty involvement in student learning.

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ABI AGHAYERE

Abi Aghayere is associate professor of civil engineering technology at Rochester Institute of Technology and the Faculty Associate for Scholarship in CAST. He received a B.S. in Civil Engineering from the University of Lagos, a S.M. in Structural Engineering from MIT, and a Ph.D. in Structural Engineering from the University of Alberta. Dr. Aghayere has over 16 years consulting experience and he is a registered engineer in Ontario, Canada.

Appendix 1

STRUCTURAL ANALYSIS STUDENT SURVEY INSTRUMENT
Fall Quarter 2003

- **Please rate each of the Intended Learning Outcomes (ILOs) on a scale of 1 (least understood) to 5 (very well understood) after each module is completed, by ticking the appropriate box.**

- **Please submit your surveys to me *at the end of each module*.**

Thank you in advance for your participation and cooperation, and for helping me to help you learn better!

MODULE #1

INTENDED LEARNING OUTCOMES (ILOs):

After completing this module, you should be able to:

	5 = very well understood	**4= understood**	**3 = some-what understood**	**2 = not well understood**	**1 = not understood at all**
➢ Describe the function and purpose of a structure.					
➢ Identify the different types of structures and structural elements					
➢ Identify the process involved in the creation of a typical civil engineering structure					
➢ Identify and calculate the different types of loads acting on a structure or structural element. e.g. Dead loads, Live loads, Wind Loads					
➢ Calculate applicable live load reduction and reduced live load on a structural element					
➢ Differentiate between concentrated loads and uniformly distributed loads.					
➢ Work through the examples in Text #1 and complete the first question in homework #1					

	5 = very well understood	**4= understood**	**3 = some-what understood**	**2 = not well understood**	**1 = not understood at all**
➢ Calculate the tributary width and tributary area for beams, girders and columns.					
➢ Describe the concept of load path (i.e. how a load is safely transferred from the point of application in a structure to the ground) and perform a load path analysis.					
➢ Identify the different types of *structural support* and the number of unknown forces in these supports.					
➢ Differentiate between the different types of connections between *structural members*					
➢ Model a structure using center-line representation, and dimension the model.					
➢ Identify one-way load and two-way load support systems, and carry out the modeling of structures for these types of load systems					
➢ Identify and state the equations of equilibrium, and draw free body diagrams (FBD) by "cutting" and isolating portions of a structure					
➢ Identify statically determinate, statically indeterminate, stable and unstable beams and frames as well as the degree of indeterminacy of a structure.					
➢ Work through examples in text #1 and text #2					
➢ Complete homework assignment #1					

OVERALL COURSE LEARNING OBJECTIVES or OUTCOMES

After completing this course, you will be able to:

	5 = very well understood	**4= understood**	**3 = some-what understood**	**2 = not well understood**	**1 = not understood at all**
1. Model structural systems properly and efficiently, and determine the loads acting on structures and their members. a, b, f, 10, 11*					
2. Analyze statically determinate and indeterminate structures to determine the support reactions; and the shear force, bending moment and axial force in the structural members. a, b, f, 10, 11					
3. Interpret and verify the results of computer-aided analysis using approximate and "exact" hand calculation methods. a, b, f, 6, 10					
4. Identify the gravity and lateral load-resisting systems used in structural systems a, b. f, 10, 11					
5. Conduct, analyze and interpret experiments or carry out research using the internet and write a report based on the research c, g, h, i, k					

* The numbers and letters correspond to the ABET TC2K a-k Criteria