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Use of Alumni Advisory Board in Assessment of Achievement of Student Outcomes in Capstone Design

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This paper discussed the use of the Alumni Advisory Board in assessment of capstone design projects. Since it is an ABET requirement that engineering programs obtain input from outside constituents on the continuous improvement processes for their programs, practically all engineering departments have established some form of external alumni advisory board which meets with the department administration and faculty on a regular basis, usually every semester. Since these boards are already in place, they can be used to assess the achievement of ABET student outcomes in the capstone design course. Specifically, the Alumni Advisory Board can be used to evaluate students' oral presentations, if the schedule of their visit is aligned to coincide with the required presentations of the capstone design course. The Alumni Advisory Board members can also evaluate the final written project reports, which can be done anytime after the completion of the student projects, and so is not schedule dependent. At Bradley University we have conducted both of these assessments over the last ten years. An evaluation template has been developed for the final written reports that covers most of the ABET student outcomes a-k. A rubric has also been developed for evaluation of student poster presentations.

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Introduction

In order to receive accreditation, all engineering programs must demonstrate, through quantitative assessments, that their students achieve all of the ABET student outcomes a-k by the time they graduate. The required ABET student outcomes are:

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Student achievement of these outcomes can be assessed at any point during the curriculum, as long as it is done by the time of graduation. Most universities have developed similar sets of assessment tools, which may include standardized exams, such as the FE exam, student exit surveys, and assessments of students' in-class work, through portfolios, case studies, exams, or other methods.

Since the senior capstone design course often involves working for an external client, either from industry or for a national design competition, capstone courses naturally address the students' competency in mechanical design (outcome c). Furthermore, most, if not all, of the ABET outcomes a-k are addressed in the process of completing the design task. Therefore, if properly organized, a capstone course can be used to demonstrate that a program's graduates meet all of the relevant ABET outcomes. Assessment tools that are utilized in capstone courses can include faculty evaluation of reports and presentations, peer evaluations, and client evaluations. With a suitable rubric the specific evaluation questions can be mapped to ABET student outcomes.

In addition to these tools, a program's alumni advisory board (AAB) can also be used in the assessment process. This paper discusses two different tools that are used with the AAB to assess student achievement of outcomes in their capstone design course.

Literature Review

The earliest survey of engineering capstone design courses was conducted in 1994[1] and received responses from 360 departments in 176 institutions. At that time only 40% of respondents reported having a yearlong capstone design project. 59% obtained their projects from industry, 41% required the construction of working prototypes, and 36% required a business plan.

A 2001 survey[2] found that 57% of engineering capstone design experiences are yearlong, with 31% lasting one semester, and 9% lasting one or two quarters in a 3 quarters per academic year system. This study received survey responses from 119 institutions, covering all major engineering disciplines. Further, 47% of respondents reported that at least some of their project teams were interdisciplinary. 88% of institutions had group projects, while 10% had individual projects. 70% reported that they assess ABET outcomes a-k for capstone projects, and 94% report requiring student oral presentations, and 91% require a written final project report.

The most recent survey of engineering capstone design courses was conducted in 2005[3]. It was conducted as an online survey, receiving responses from 444 departments in 232 institutions. They found an increasing number of interdisciplinary teams compared to the 1994 survey data. 71% obtained their projects form industry. They also note that the number of hours per week the students are expected to work on the project has increased from the 1994 data.

A survey was conducted solely of mechanical engineering capstone design in 2003[4]. 46 schools responded. 100% reported having students work in teams, with typical team sizes of 2-5 students. 81% involved some sort of industrial interaction, with 65% receiving significant funding from industry. 91% required students to build a working device.

Other studies have looked at specific assessment mechanisms. Sobek and Jain[5] developed a Client Satisfaction Questionnaire to use project client feedback to assess achievement of outcomes. Their tool primarily related to outcome c, but also addresses communication skills (outcome g). Biney[6] presents a rubric for faculty grading of final senior design reports that covers 8 of the 11 ABET student outcomes. General issues related to organization and operation of a capstone course are discussed by Dutson et al.[7]

Assessment Tools

There are two assessment tools that make use of the Alumni Advisory Board that are utilized in the senior design course in the mechanical engineering department at Bradley University. The first is the AAB's evaluation of the final written project reports, and the second is their evaluation of students' poster presentations in the last month of the 2-semester course.

Written Final Reports

A selection of final written project reports is provided to the AAB. Not all project reports can be used because of issues of confidentiality and intellectual property with certain clients and potential conflicts of interests with others. One member of the AAB serves as the organizer to distribute the reports and collate the results. AAB members are asked to evaluation how well the report satisfies each of 22 criteria, using a Likert scale (1-5). These criteria are listed below with relevant ABET outcomes in parenthesis afterwards.

1. Identity and role of the students & faculty advisor
2. Client identity and contact point is clear (g)
3. Objectives and goals of the project are clear (g)
4. Engineering challenge is clearly stated (e)
5. Technical approach used for a solution is feasible
6. The technical approach is reasonable (e)
7. Schedule of activities is clearly defined
8. Spending plan for the project is clear (h)
9. Deliverables transferred to the client are clearly stated
10. Results are valuable to the client (c)
11. Project was a valuable learning experience (i)
12. Project represents activities by a practicing engineer (k)
13. Report contains evidence of a team effort (d)
14. Report demonstrates a multi-disciplinary solution (d)
15. Report demonstrates shows math, science, and engineering discipline advances (a)
16. Report demonstrates an ability to design and conduct experiments (b)
17. Report demonstrates an ability to analyze and interpret data (b)
18. Report demonstrates an ability to design to meet the needs of the client (c)
19. Report clearly summarizes results and conclusions (g)
20. Report shows project objectives and goals were achieved

21. Rating of the technical challenge of this project
22. Rating of the overall quality of this project report

Thus 9 of the 11 ABET outcomes are covered in this scoresheet. The only ones not covered are ethics and contemporary issues.

Poster Presentations

Students make posters for their projects in the last month of the course, when they are nearing completion

of the projects. Working hardware is required for most of the projects. The scoring of the posters primarily addresses ABET outcome g, an ability to communicate effectively. The items on the poster presentation scoresheet are listed as follows:

Bradley University
Mechanical Engineering Department
Alumni Advisory Council
2007 Senior Design Activity Presentation Scoresheet
Team/Title of Activity _____ Team # __
Evaluator's Name _____
Please evaluate each Team's Presentation using the following metrics. Indicate a score of 1-5 for each of the following three categories with a score of 5 being the best.

1 Communication
- Are the names of the Client, Team Members and Faculty Advisor identified?
- Is the purpose of the project clearly stated?
- Is a Project schedule and/or budget presented?
- Does the project represent teamwork?

2 Technical Challenge
- Does the Project represent a significant engineering challenge?
- Is there a clear plan for meeting the project's goals?
- Are the team members able to present a clear understanding of the project's activities?

3 Engineering Activity
- Have the team members applied the principals and practices of engineering to meeting the Project's goals
- Does the activity involve the design of a system, component or process?
- Is the Project representative of the activities of a practicing engineer?

Comments:_____

The results of the poster evaluations are tabulated immediately, and the top four teams are then selected to give oral PowerPoint presentations to the AAB. Those oral presentations are then scored (by all 9 attending members of AAB), and the team with the highest score is recognized as the outstanding senior design team for that year.

Results

For 2009, 10 of the final project reports were reviewed, each by 3 members of the AAB. The scores ranged from a low of 3.69 on question #14, to a high of 4.58 on question #3, with an overall average around 4 out of 5. Each participating member of the AAB reviewed 2-3 reports. We have been asking same set of 22 questions since 2002.

For the Spring 2008 Poster Competition, there were 17 teams. Scores ranged from 9.7 to 14.0 (out of a possible 15.0), with an average of 11.7. On average, each poster was evaluated by three members of the AAB.

In addition to the quantitative results, members of the Alumni Advisory Board (AAB) also provide written comments on the reports. A selected sampling of comments follows –

"The project report addressed the main objectives, but it was overly long. Technical reports need to be concise while delivering the necessary information, preferably with impact? Using annotated cross figures and graphs help."

"Overall a good engineering project with a healthy dose of some finance and costing. Very well done overall. The report was the best-written report that I have read as a member of the advisory board. Very professional, no misspellings or other glaring errors, however the "change bars" from MS Word were left in the final document that distracted attention. These could have been turned off for the final edition and it would have made the report much better from a format perspective. One of two very good reports I reviewed this year. They keep getting better."

"No budget or costs were included for project including prototypes. No detailed schedule provided. From business perspective, report writing could be stronger."

"I am unclear about the audience for the report. Some of the details appear to be written for the benefit of future students and not the clients."

"This project report contained all the elements required by the client. However, it was overly long and wordy. Technical reports should be clear, concise, and impactful. Annotated figures and graphs could help reduce the text and provide a visual representation of the text."

"Very good lineage and example of scientific problem solving, yet conclusion and recommendations are a bit wordy and need to be more succinct for understanding. Technical details delivered favorably and succinctly can carry an impression from good to great."

"The report is very well written and organized. An executive summary at the front would have helped the

reader, who would likely be a team leader or engineering manager, get to the point of the report quickly. Must hold the reader's interest. Time seemed to be a constraint to getting everything done. Overall a typical engineering project. Very well done overall. The report was the best written report that I have read as a member of the advisory board. Very professional, no misspellings or other glaring errors that distracted attention."

"Without a farm equipment background, I found it very difficult to clearly understand the engineering problem and what the students were trying to accomplish. For example, the text was not supported with diagrams or clear pictures to clearly define the problem and proposed solutions. The text seemed repetitive with generalized statements but little detail as to the problem being addressed."

"The report is well written and reflects a project that was well planned and executed. I think the team made a good choice to investigate and recommend a solution to the issue of pin wear they came upon even though it was not part of the requested work. I was a little disappointed that the team seemed to run out of ideas on resolving the hysteresis issue; it seemed to me they could have spent some time trying to understand why different knife designs demonstrated different response characteristics and then used that understanding to promote further idea generation. All in all, a good effort."

Conclusions

An external alumni advisory board can be used to evaluate capstone design projects. Their evaluations can be used for course improvement and to fulfill ABET requirements to assess achievement of student outcomes.

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