The Capstone Design Course and Its Failure to serve as An Effective Outcome Assessment Tool

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Abstract:

This paper presents the results of a 5 year study at Southern Polytechnic State University of the effectiveness of a capstone design course as an outcomes assessment tool. The study clearly demonstrated that the course has merit in the curriculum but fails as an outcomes assessment tool. It is shown that the primary difficulty faced when attempting to use a capstone design course as an assessment tool lies with the quantification of findings. The sharing of results with colleagues to facilitate improvements to the curriculum rarely goes beyond the anecdotal level since many intangibles are noted and are not measurable. Examples of the attempts to produce useable quantifiable feedback are given along with suggestions for further study.

Introduction:

As stated this paper deals with the findings of a 5 year study of the capstone design course required of all civil engineering technology students at Southern Polytechnic State University (SPSU) and the attempts to use this course as an effective outcomes assessment tool. First, outcomes assessment in the context of the study is described and discussed. Likewise, the capstone design course is described and the learning outcomes for this course presented. The many attempts to measure the learning outcomes of the civil engineering technology program using the capstone course are described and the successes and failures identified. It is concluded that the capstone course, while worthy of a spot in the curriculum, is not an effective tool for assessing program outcomes. The 5 year history at SPSU strongly supports this conclusion.

Effective Outcomes Assessment:

Educators by their very nature are skeptics. Having reviewed and graded hundreds upon hundreds of student papers, the words outcomes assessment are often interpreted as faculty evaluation regardless of what administrators or others may say. Unfortunately, faculty are often correct in their assumption that outcomes assessment procedures are just another form of faculty evaluation to be added to the long list of faculty evaluations already in place. It was clear throughout the 5 year experience that both faculty and administrators alike understand what outcomes assessment is and is not, but must be reminded often that it is not faculty evaluation. It is because of this experience that we must take the time here to review what is outcomes assessment and what makes an effective outcomes assessment tool.

The need to assess outcomes is not something new. Any student of education is taught early on that the ability to assess or evaluate the effectiveness of teaching is paramount to the achievement of the desired goal. Additionally, the primary measures of effectiveness of teaching are the outcomes achieved. While this may appear to some to be a justification for evaluating faculty through the use of student evaluations, those who would make such an argument would be focusing solely on one course and neglecting the curriculum. Assessment is not evaluating faculty nor is it evaluating one course; the object of assessment is the curriculum. A curriculum which is flawed but is taught by talented faculty is still flawed.

An effective outcomes assessment procedure will identify flaws in the curriculum and lead to improvement. Outcomes assessment leads to the identification of curriculum strengths and weaknesses and points towards the changes needed to correct the weaknesses and reinforce the strengths. It must be restated that outcomes assessment is not a faculty evaluation tool and should not be treated as such neither by administrators nor faculty. We found this easier said than done. When we found students weak in certain subject areas, it was very easy to blame a particular faculty member for that weakness. Yet, upon further examination, more often than not the source of the weakness was beyond the control of the professor.

While this may be putting the cart before the horse, we have found through our efforts that an effective outcomes assessment tool has certain characteristics. Later, it will be shown which of these characteristics the capstone course fails to possess and why it fails to be an effective tool.

First, an effective outcomes assessment tool must be easy to administer. If great difficulty is encountered gathering and analyzing data two mindsets develop. First is a reluctance to conduct the activity at all. It is suggested that many schools conduct assessment activities because of accreditation requirements not because they think the activities will lead to a better curriculum. Further, it has been my experience as a TAC/ABET evaluator that those schools with easily administered assessment tools are far more likely to use the results of the activities to improve their programs than those who have difficult procedures.

The second mindset is that of skepticism. Tools which are hard to administer lead faculty to be skeptical of the results. As engineers we are well versed in the inherent inaccuracies and lack of precision which creep into a result the more calculations we must complete in order to get to that result. So it is with assessment. The more steps in the data acquisition and reduction process, the less precise the results and the less faith we have in the application of the results.

To be an effective outcomes assessment tool, it must be clear from the outset what is being assessed. A learning outcome can be defined here as something that because of his studies the student can do at the end of his college experience that he could not do or could not do well before his college experience. What are the outcomes to be assessed? Is it all of the curriculum including those areas beyond which the department has control or is it only those areas within the department s area of responsibility? We found these to be extremely difficult questions to answer. While outcomes assessment is meant to improve the program in its entirety, realistically dealing with other departments and programs to facilitate changes is difficult if not impossible. This affected our ability to develop the list of learning outcomes to be evaluated. Recognition that

even if a weakness were found that it would be nearly impossible to bring about a change caused us to avoid including those learning outcomes in our list.

A third characteristic of an effective outcomes assessment tool is its ability to quantify the results. This may appear to be trivial at first examination, but we found it to be important in order to identify what has improved versus what has not. Again, as engineers we are by our very nature as much if not more in tune with numerical communication as verbal communication. Quantifying results and seeing the change in those results over time is extremely helpful. Non-numerical representations were difficult to use, often because interpretation of the wording varied from person to person.

We discovered that an effective tool is one which produces results which can be communicated to others easily. While this may appear to be a restatement of the previous paragraph, it is not. Communication within the department and the use of quantifiable results to affect that communication needs to be supplemented by easily interpreted summaries. These summaries need to present both numerical and verbal results in a clear and concise manner. This is the only way that the interrelationships of all the learning outcomes and their assessment can be properly summarized and utilized. As will be seen later, this task was much greater than first anticipated.

In summary, it was our desire from the outset that the outcomes assessment procedure be effective at analyzing changes to the program s curriculum. This before and after type analysis required an effective tool. We found through our efforts that an effective tool is one which:

1. Is easy to administer;
2. Clearly defines what is being assessed through well defined learning outcomes;
3. Produces quantifiable results; and
4. Facilitates communication of the results.

The Capstone Design Course:

It is worthy to note at this juncture that the capstone design course is still viewed as an essential part of the civil engineering technology curriculum at SPSU. Experiences when attempting to use the course as an outcomes assessment tool have not diminished its role in the education of our students. If anything, having taught the course to over 350 students in the last 5 years, its value has been recognized by both faculty and students alike.

Before proceeding with a discussion of the attempts to use the course for assessment, a description of the course will be presented. The capstone design course is best described by reviewing the syllabus. What follows is the course syllabus; the Topical Outline has been removed in the interest of space.

CET4480
Senior Project

Course Description:

Designed to be the culmination of their undergraduate civil engineering technology education, this course will provide students with the opportunity to work on real world civil engineering projects. Working in teams, students will choose from proposed ongoing projects within the metropolitan area of Atlanta, design or redesign one of these projects, and present their results for review to a panel of faculty and students.

Class Schedule:

One hour lecture and Nine hours lab for Four semester hours credit

Projects:

This class consists of one large project completed by teams of two or three students. The project is broken down into two distinct phases called Preliminary Engineering and Preliminary Design. Preliminary Engineering is a feasibility study comprised of data collection and analysis and generation of three or more feasible proposals to solve the engineering problem addressed. Preliminary Design is a more detailed design of one of the selected alternatives generated in the Preliminary Engineering phase and includes a complete set of engineering plans and a detailed design report. Each student design team meets with the instructor each week to present their progress and receive direction for the following week.

Computer Usage:

1. *Word processing*
2. *CAD*
3. *Discipline specific software unique for each project*

Learning Outcomes: (Upon completion of this course students will be able to:)

1. *Prepare a scope of services for a project*
2. *Practice how to work together as a design team*
3. *Prepare technical reports*
4. *Identify the data collection needs for a project*
5. *Orally present their findings to their peers and faculty*
6. *Prepare meaningful progress reports*
7. *Prepare a set of engineering plans*
8. *Present and defend a proposal for a project*

9. *Integrate knowledge from other classes*
10. *Work independently*
11. *Prepare a feasibility study*

Grading:

Progress Reports	*10*
Preliminary Engineering	*40*
Preliminary Design	*50*

The reader will note that this syllabus is similar to the typical syllabus for capstone design courses offered by engineering and engineering technology schools throughout the nation. The course was developed to be a viable capstone course and was not designed to be an assessment vehicle. It was only after the course was instituted that its use to assess the program was attempted.

Attempts at Measuring Outcomes:

Before one can measure learning outcomes one must have defined those outcomes for the program. The CET program s learning outcomes are stated below. It was these outcomes which we tried to assess using the capstone project course.

Program Outcomes

1. *Conduct design, lay out and supervision of a civil engineering system or project using standard design methods, practice, and procedures.*

2. *Collect and analyze relevant data for the purpose of developing an engineering decision, design, or layout.*

3. *Effectively communicate information in these formats: written, oral, graphical, and mathematical.*

4. *Apply appropriate software to solutions of problems in civil engineering technology applications.*

5. *Have knowledge and understanding of professional careers in civil engineering technology and the importance of continued professional development and lifelong learning.*

A first look at these outcomes would falsely lead one to believe that they are easily measured. However, when put into practice this measurement task becomes difficult. While each can be measured, the quality of the results of that measurement is lacking.

At first it was thought that having the instructor review the students progress at mid term and at the end of the term would provide sufficient information to share with other faculty as to the degree to which the learning outcomes had been achieved. Since the capstone course was restricted to graduating seniors, the class would have already gone through most of the curriculum and sufficient evaluation could be accomplished.

While this appeared to be easily accomplished, it proved to be otherwise. In particular, it was discovered that the program outcomes, which had been left particularly broad so as not to restrict future curriculum development, were too broad to be effectively assessed. Each faculty, of which there were only 3 over the 5 year period, who taught the senior project course had a slightly different interpretation of what performance level by the students satisfied each of the program outcomes. Without a clear standard for the measures of effectiveness, the value of the results suffered and comparisons from semester to semester and year to year were impossible.

As stated earlier, without clearly defined learning outcomes, it is impossible to have a useful outcomes assessment tool. Yet, by defining program outcomes too specifically so that they can be measured, future curriculum development and refinement are stifled and the major reason to accomplish the outcomes assessment task becomes impossible. Repeated attempts over the years to overcome this have met with failure.

In addition to the above, student peer reviews, review by teams of faculty, reviews by members of the industrial advisory committee and personal interviews with class members throughout the semester have all been tried. In all cases the first stumbling block was the definition of the program s outcomes which in turn leads to results which are useful primarily to the one doing the assessment but nearly impossible to communicate with others.

A second stumbling block encountered was the capstone course s inability to address the spectrum of outcomes for each of the students. False readings as to the level of ability evidenced by the class were obtained because students worked as groups. Working within groups it was easy for students to hide their weaknesses. For example, in a group of three students only one may know how to put a project together. As a result, that student would direct the others and give the impression that all in that group knew how to put a project together. Extrapolating this situation to the entire class, it becomes obvious that the majority of the class, two-thirds in this example, could have a glaring weakness, yet it would not readily be identified.

Even with clearly defined outcomes the capstone design course fails as an assessment tool because it cannot produce quantifiable results. Attempts to assign numerical value to peer evaluations, faculty evaluation of projects, and the like failed because the definition of success and the various degrees of success varied from semester to semester and year to year depending on the instructor and projects produced. Since the same projects cannot be used over and over, for obvious reasons, the variability of projects from semester to semester inserts yet another difficulty into the assessment task.

Finally, since these difficulties proved insurmountable, the problems associated with communicating the results to engineers and non-engineers became mute. Since meaningful results

could not be produced for internal use, there was little reason to attempt to communicate anything outside the department.

Success and Failure:

It is not necessary to restate the failures but rather is important to identify the successes which came out of the work. With such a dower view of the experience the reader may wonder what, if any, successes could have come from this endeavor. Two immediately surface.

First, we set out to see if the capstone design course could be used as an effective outcomes assessment tool and we found that it could not. However, in the process we reinforced the notion that the capstone design course is a valuable part of the curriculum. We saw this over and over again when interviewing students, speaking with the industrial advisory committee members and discussions among the faculty.

Secondly, we learned that if outcomes assessment is to become part of the process, which TAC/ABET says it is, then major effort must be put into properly identifying learning outcomes. Crafting program outcomes which allow for curriculum flexibility yet are detailed enough to produce meaningful results is the true challenge to be faced by engineering educators. Until this challenge is met, it is this author s opinion that proper outcomes assessment cannot take place.

Conclusion:

One of the first things you learn in writing technical papers is that there should be a conclusion section. Thus, the reason for this section. The one conclusion I wish to leave the reader is that outcomes assessment is an extremely valuable tool but that it is an extremely difficult task as well. Without sustained effort, meaningful results can not be obtained. As was explained, our 5 year experience at SPSU has yielded a further appreciation for the complexities of the process yet has not dulled our enthusiasm to make it an integral part of the education process. The reader is encouraged to do the same.

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