

Direct Versus Indirect Assessment Methodologies

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Abstract

The paper discusses direct and indirect student assessment methods, used by the Department of Engineering Technology at the University of Arkansas at Little Rock (UALR), and their possible applications, including the limitations of their use. Faculty members are familiar with the direct assessment of their students via exams, quizzes, and reports etc. Indirect assessment methods include surveys and questionnaires. At the conclusion of almost every college-level course students are asked to complete an end of semester course evaluation form. This paper discusses how the Department has modified its end of course evaluation form to include a student self-assessment section. This self-assessment section generates indirect assessment data, which complements the traditional direct assessment data.

Introduction

UALR offers baccalaureate degrees in Electronics and Computer Engineering Technology (ECET) and Mechanical Engineering Technology (MET). As with all degrees accredited by ABET, these degree programs are required to implement a continuous improvement plan (CIP). ABET states that¹: “The program must use a documented process incorporating relevant data to regularly assess its program educational objectives and program outcome, and to evaluate the extent to which they are being met. The results of these evaluations of program educational objectives and program outcomes must be used to effect continuous improvement of the program through a documented plan.” At the core of the CIP must be the program or student outcomes. In the most recent evaluation of its student outcomes the ECET program decided to adopt ABET’s general criteria 3 of ‘a’ through ‘k’, along with ABET’s specific program criteria, as its student outcomes. Assessment of the student outcomes should be done ideally using a variety of different methods^{2,3,4}. Such methods have traditionally relied upon direct measurements such as tailored exam questions, quizzes, and laboratory assignments. Other methods, which are less applicable to the student outcomes and more so to the program educational objectives, include exit surveys of graduating seniors and surveys of employers’/employees’ (former graduates) job satisfaction. The CIP must use the results of these measurements to make positive changes to the program, in a well-documented manner. For the CIP to be successful it must be well defined and manageable. Often programs accumulate a great deal of data, but struggle to use it effectively. Other times programs identify deficiencies and make appropriate course/curriculum changes but fail to document them.

Direct assessment methods measure students’ performance and allow faculty to ultimately assign student grades. With regard to ABET, the greatest difficulty encountered with direct assessment is taking this data and using it routinely in a CIP, without overwhelming faculty. Direct assessment is essential, but its collection and efficient use continues to stymie many programs⁵. Indirect assessment methods do not directly measure students’ performance, but can provide

useful information. They can also be used in a routine way with a relatively low burden on faculty time. Indirect assessment should be viewed as an augmentation to direct assessment⁶.

The Modified End of Course Evaluation Form

The Department recently modified its end of course evaluation form so as to use it as an additional assessment tool. The form previously consisted of questions related primarily to the instructor. Each course now has its own custom evaluation form. Figure 1 shows the new end of

<p>Course</p> <ol style="list-style-type: none"> 1. The course serves an important part of my degree objectives 2. The required prerequisites are adequate and justified 3. The course provides a balance between theory and applied experience 4. The sequence of course topics reinforces my learning experience 5. The textbook and reference materials, if any, are useful and adequate <p>Instructor</p> <ol style="list-style-type: none"> 6. The instructor is well prepared 7. The combination of lecture and visual presentations helps me better understand the course material 8. The instructor encourages student questions and manages classroom interaction 9. The instructor is available to students who are in need of help 10. I highly regard the instructor's performance in teaching this course <p>Student self-assessment of course learning objectives</p> <ol style="list-style-type: none"> 11. I am capable of using K-maps with up to six variables. 12. I am capable of implementing combinational logic circuits using VHDL. 13. I am capable of analyzing synchronous state machine circuits. 14. I am capable of designing and implementing sequential logic circuits using VHDL. 15. This course has improved my ability to identify, analyze, and solve technical problems. 16. This course has stimulated my interest in seeking further knowledge in this field.
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Figure 1. The End of Course Evaluation Form for ECET 4407.

course evaluation form for the Digital Systems Design course (ECET 4407), which is typical of a senior-level digital design course consisting of combinational, sequential, and VHDL design. Students answer each of sixteen questions using a letter scale of “A” through “E”, where “A” means “strongly agree”, “B” means “agree”, “C” means “neutral”, “D” means “disagree”, and “E” means “strongly disagree”. The first two parts of the form are common to all courses. Part one consists of five questions, which deal with such topics as prerequisites, the course textbook, and course structure. The second part of the course focuses on the instructor and addresses such issues as: instructor preparedness, accessibility of the instructor, and the management of the course. Questions 11 through 16 on the form are related to some of the student outcomes via the learning objectives of the course. The number of questions in part three of the form varies from course to course. For the ECET 4407 course, questions 11 through 14 address the four specific course learning objectives:

1. To be capable of using K-maps with up to six variables.
2. To be capable of implementing combinational logic circuits using VHDL.
3. To be capable of analyzing synchronous state machine circuits.
4. To be capable of designing and implementing sequential logic circuits using VHDL.

These course learning objectives are related to the following ECET student outcome and ABET general criterion:

“An ability to identify, analyze, and solve broadly-defined engineering technology problems” (ABET general criterion 3f).

Questions 15 and 16 seek to gauge the general value placed on the course by the students. The evaluation forms for other courses are similar, with questions 11 onwards being related to the learning objectives of the respective courses and the appropriate ABET criteria.

Indirect Assessment Results

Using the end of course evaluation form, students were asked to self assess their ability in the areas identified by the course learning objectives. The results of the student self-assessment of course learning objectives questions for ECET 4407 (ten students in the course) are shown in figure 2. The student responses of “A” through “E” were converted to a 4.0 GPA scale in the standard way, with an “E” being considered equivalent to an “F”. In this way, an equivalent class GPA was obtained for each question.

The results of the students’ self-assessment shows that for questions 11 through 14, students generally answered between “strongly agree” and “agree”. This is considered to be a positive result. Responses to questions 15 and 16 are close to an overall response of “agree”, however a more positive response would be desirable. The results are skewed slightly by one student’s response of “strongly disagree”. The anonymity provided by the end of course form does not permit the reason for this response to be determined.

Indirect Assessment						
Student Self-Assessment of Course Learning Objectives	Number of A's	Number of B's	Number of C's	Number of D's	Number of E's	Equivalent GPA (4 to 0 scale)
11. I am capable of using K-maps with up to six variables.	7	2	0	0	1	3.40
12. I am capable of implementing combinational logic circuits using VHDL.	6	3	0	0	1	3.30
13. I am capable of analyzing synchronous state machine circuits.	5	5	0	0	0	3.50
14. I am capable of designing and implementing sequential logic circuits using VHDL.	6	4	0	0	0	3.60
15. This course has improved my ability to identify, analyze, and solve technical problems.	3	4	2	0	1	2.80
16. This course has stimulated my interest in seeking further knowledge in this field.	4	2	3	0	1	2.80

Figure 2. Results of Indirect Assessment for ECET 4407.

Direct Assessment Results

The four course learning objectives were measured using exam questions, as shown in figure 3. One specific exam question was associated with each learning objective, permitting that learning objective to be measured by direct assessment. The points scored per question were converted to a percentage scale and then to an “A” through “F” scale, using the traditional grade assignments (e.g. >90% corresponds to a “A”, >80% but less than <90% “B”, etc.). Figure 3 shows the breakdown of letter grades received for each exam question. The equivalent class GPA is shown for each question, based on a 4.0 scale.

Direct assessment provides the most accurate measure of a student’s knowledge in a given course. In this course, a majority of students was able answer these questions with a grade of either an “A” or “B”. Some students were not able to answer the questions successfully, obtaining grades of “F”. It should be noted that these students could still possibly pass the course if they performed better on other exams, quizzes, and laboratories.

Direct Assessment (Associated Exam Questions)						
Course Learning Objectives	Number of A's	Number of B's	Number of C's	Number of D's	Number of F's	Equivalent GPA (4 to 0 scale)
1. To be capable of using K-maps with up to six variables.	7	2	0	1	1	3.18
2. To be capable of implementing combinational logic circuits using VHDL.	6	2	0	0	3	2.73
3. To be capable of analyzing synchronous state machine circuits.	8	1	0	0	3	2.92
4. To be capable of designing and implementing sequential logic circuits using VHDL.	8	1	2	0	1	3.25

Figure 3. Results of Direct Assessment for ECET 4407.

Use of the Indirect and Direct Assessment Results

The average of the direct assessment of the four course learning objectives is 3.02, or a grade of “B”. This seems reasonable. The “F’s” obtained by some students warrant attention, in particular the 3 “F’s”, for learning objectives 2 and 3. The fact that these students obtained these grades indicates a deficiency in their course knowledge. If a similar result were obtained in future course offerings then corrective action should be undertaken. This could include course or prerequisite changes. The average of the indirect assessment of the course learning objectives (questions 11 through 14) is 3.45, or an equivalent grade of “A/B”. Clearly, these results do not fully reflect the reality of what students can actually do in the course. It appears that some students had an inflated view of their own capabilities.

Taken together, on average both assessment methods are generally consistent. However, the direct assessment method must be considered the “gold standard”, because it measures actual student performance. Correlated, positive results from both assessment methods can reasonably be assumed to indicate that no corrective action is required. Generally, it would be expected that the two assessment methods would return correlated data. Therefore, a broad deviation between the indirect and direct measurements should be investigated. In the case of a specific self-assessment question asked of students, a negative response (especially very negative) would be a cause for concern, as it indicates that a student does not feel confident about that topic. This cause for concern would be amplified if the overall average response from all students was negative and would certainly indicate that corrective action is warranted. However, if the negative response is limited to a single or very few students then corrective action may not be required. Positive or very positive indirect responses do not guarantee that students actually have the capabilities that they indicate, as shown from figures 2 and 3.

By embedding indirect assessment into the end of course evaluation form, assessment data can be collected easily. Over the course of several semesters this data can be plotted. Viewing the data in this way should reveal any trends that may be present. Any negative trend over the course of several semesters, in which student responses indicate that they have become less confident in their capabilities, should be of concern.

Conclusions

Indirect assessment strategies may be easily implemented by embedding them in the end-of-course evaluation form. Positive results must be confirmed by direct assessment methods, because students may overestimate their abilities. Negative responses should be examined carefully, particularly if they are broadly based, i.e., represent a significant percentage of the class. Plots of indirect assessment results over several semesters may reveal subtle trends, which if negative could serve as an early warning sign for problems with the course.

Direct assessment via exam questions, quizzes, and lab reports provides a definitive measure of the students' capabilities. Indirect assessment can only complement direct measures. However, direct assessment usually requires more time to structure and obtain. It may not be as easy as the indirect method to compare data from different semesters because the actual exam questions etc., will most likely change in different course offerings.

The indirect assessment methodology presented in this paper could be adopted for use by any ABET accredited program. As more indirect assessment data is collected over subsequent course offerings, a more significant discussion and analysis of this specific course data will be possible.

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Biographical Information

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Dr. Menhart currently serves as a Professor of Electronics and Computer Engineering Technology at the University of Arkansas at Little Rock. He teaches courses primarily in digital systems design (VHDL) and microcontrollers. His current research interests include digital control and energy efficiency related issues.