TOWARDS ABET ACCREDITATION FOR A SWE PROGRAM: ALTERNATIVE STUDENT ASSESSMENT TECHNIQUES

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ABSTRACT: This paper describes assessment techniques utilized for assessing undergraduate students studying in a software engineering program. The purpose behind this work is to get the program accredited by the Accreditation Board for Engineering and Technology (ABET). Therefore, a number of applied direct and indirect assessment techniques are described. These techniques are implemented towards the end of the semester to assess the extent to which the student and course outcomes are satisfied. Consequently, results are obtained and analyzed and various learning issues are eventually identified. Finally, the paper provides suggestions for improvement in course delivery as well as student learning mechanism.

Key Words: ABET, Accreditation, Student Outcomes, Course Outcomes, Assessment

INTRODUCTION

Quality of education is a major goal for every institution. For achieving this goal institutes design best curricula and hire well experienced and high caliber faculty members. As we acknowledge we are not living in a perfect world. We are relying on a high percentage of our students to meet our quality standards. Quality standard depends upon assessments, measurements and comparison to meet our target values. Currently the standard of Software Engineering education is increasing day by day. So, best curriculum is required to meet the demands of industries.

The traditional style of teaching such as lectures is effective only to certain extent. Whereas project based teaching is effective only to global learners. Apart from these, a successful student is encouraged to shift his learning from passive aspects to active aspects of education [1]. In turning from passive to more active learning approach the lecturer selects a course which is linked step by step to create the interest of the student moving topic wise [2].

Our paper will explain the course assessment in two ways, direct (teacher's viewpoint) and indirect (student's viewpoint) assessment of student in terms of course assigned. In our approach stress is made upon methodology in which various techniques are employed to judge the skills of the students. Indirect assessment in terms of Course Outcomes (CO) and Student Outcomes (SO) is also performed using various methods. SO is also assessed through direct assessment. An online survey to evaluate courses for the global satisfaction of students through a list of general questions related to the course, the teacher and the learning process is also taken from the students. Learning barriers and issues are discussed on the basis of direct and indirect assessment and various plans are proposed for the improvements.

RELATED WORK

Saxena Varun et al. assessed failure of the students in different courses and suggested different remedies for the improvement of their skills, deficits and their effectiveness. Confidence was considered as one of the basic remedy for the improvement of poor performance of the students [3]. Darla K. Deardorff studied about intercultural assistance of students on the basis of internationalization through appropriate assessment methods. According to him it is best to use both qualitative and quantitative methods for the assessment of students involving interviews, observation, and judgment by self and others to assess intercultural competence among students [4]. Olaf Hallan Graven and Lachlan Mhor MacKinnon evaluated the richness, flexibility and easy applicability of software for the assessment of the students by designing various multi-levels and multi-player games technically in a virtual learning environment which help in the constructivist learning, engagement, and contextual socialization [5]. Sorelle A. Friedler et al. designed a grading method for the assessment of the students who are poor in one field or have a good grasp on the other. In relationship with the class, scatter plot helps the teachers to assess the students through grading system EduViz [6]. Riccardo Mazza and Vania Dimitrova suggested another method for assessment of students in distance learning classes. CourseVis, a system which involves course management system and information visualization by graphical representations for the better understanding of social, behavioral, and cognitive aspects related to learners [7]. Prakash Ranganathan and Kendall Nygard suggested Blooms Online Assessment Test (BOAT) to assess how students' response to the demands of the society on the bases of what they learned? [8]. Hairong Liu et al. developed a new system named Student Modeling System for the assessment of the students by considering time as a basic factor [9].

METHODOLOGY

▪ The assessment is based on direct and indirect assessment. The direct assessment considers the point of view of the instructor through exams, quizzes, assignments and projects. The indirect assessment considers the point of view of students through surveys. Indirect assessment evaluates the attainment of specific learning outcomes of the course as well as student outcomes covered by the course. Direct assessment evaluates the attainment of student outcomes covered by the course. To illustrate our methodology we are going to use as a sample one of the courses covered by assessment techniques. The course WE is Object-Oriented Software Engineering (SWE313). For both direct and indirect assessment, we use two alternative approaches:

- The average score achieved by students in each outcome covered by the course.
- The percentage (%) of students achieving the satisfactory or exemplary levels.
- For direct assessment, we define 4 levels of satisfaction as follows:
- Unsatisfactory is given to the students whose score is 50% or lower.
- Developing is given to the student whose score is between 50% and 70%.
- Satisfactory is given to the student whose score is between 70% and 90%.
- Exemplary is given to the student whose score is above 90%.
- For indirect assessment, since this is done through surveys with 5 levels that are:
- Strongly Agree – 100%
- Agree – 80%
- Neutral – 60%
- Disagree – 40%
- Strongly Disagree - 20%
- We defined 4 levels of satisfaction as follows:
- **Unsatisfactory**: students whose score is 40% or below (Disagree + Strongly Disagree)
- **Developing**: students whose score is 60% (Neutral)
- **Satisfactory**: students whose score is 80% (Agree)
- **Exemplary** students whose score is 100% (Strongly Agree)

COURSE OUTCOMES (CO)

1.   Course outcomes articulated by the course as follows (as defined in the syllabus of the courses):
2. Define fundamental and advanced Object Oriented Software Engineering concepts [SO k]
3. Understand how to capture system requirements in use cases. [SO l]
4. Understand how to transform an analysis models into to design models.[SO c]
5. Apply an iterative process to the development of a design model.[SO e, l]
6. Describe some basic design considerations, including the use of design patterns. [SO e, l]
7. Use of different UML Diagrams to represent analysis and design models. [SO k]
8. Use the techniques of forward and reverse engineering to generate code from UML models and vice-versa. [SO l]
9. Understand Software Processes and Software development methodologies (such as RUP). [SO e, k]
10.   USE OO Case tools (such as IBM Rational Rose) to create UML diagrams. [SO k]

STUDENT OUTCOMES (SO)

1.   Student outcomes addressed by the course are as follows (as defined in the syllabus of the courses):
2. SO (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
3. SO (e): Ability to identify, formulate, and solve engineering problems
4. SO (k): Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

5. SO (l): Ability to analyze, design, verify, validate,
6. implement, apply, and maintain software system

ASSESSMENT

The judgment of the extent to which outcomes are met is based on the following table:

Table: 1. Assessment criteria for students

Exceeds Expectations (EE)	Meets Expectations (ME)	Progressing Towards Expectations (PE)	Below Expectations (BE)	Unacceptable Expectations (BE)
Above 80%	70% - 80%	60% - 70%	50% - 60%	Below 50%
Continue the good work	Continue the good work	Attention is required to some elements	Immediate action is required to resolve issues	An immediate remedial action is required by the chairman of the program

ATTAINMENT OF COURSE OUTCOMES AND STUDENT OUTCOMES THROUGH INDIRECT ASSESSMENT

The summary of the course learning outcomes survey conducted with students at the end of the course is given below graphically,
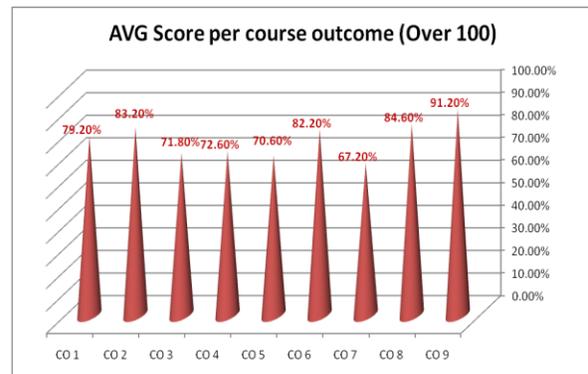

Figure: 1. Average score per CO

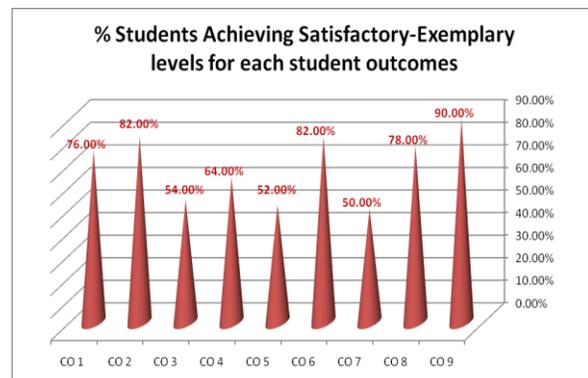The percentage acquired reveals the following graphical explanation,

Figure: 2. Percentage Student per SO

The aggregated results from course outcomes to student outcomes, when using the average score for each student outcome as well as the percentage of students achieving the satisfactory-exemplary levels, are as follows:

Table: 2. Aggregated results from CO to SO

	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)	Total	AVG	% Students Achieving Satisfactory-Exemplary levels
SO (c)	27.00%	27.00%	34.00%	6.00%	2.00%	100.00%	71.80%	54.00%
SO (e)	32.00%	32.67%	25.67%	4.33%	3.33%	100.00%	75.93%	64.67%
SO (k)	49.50%	32.00%	13.50%	1.50%	2.50%	100.00%	84.30%	81.50%
SO (l)	29.00%	33.00%	25.25%	4.75%	4.75%	100.00%	73.40%	62.00%

THE AVG SCORE FOR EACH SO

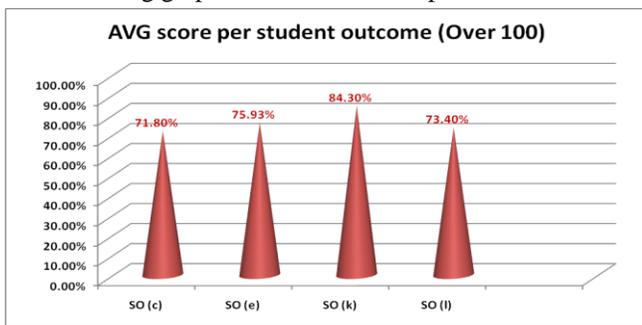The following graph shows AVG score per student outcome

Figure: 3. Average score per SO

The final results criteria according to the indirect assessment for the attainment of student outcomes are as follows:

Table: 3. Final results criteria of attainment of SO

Student Outcomes	Outcome Importance	Final Result (based on indirect assessment)
SO (c)	M	ME (AVG score between 70% and 80%)
SO (e)	H	ME (AVG score between 70% and 80%)
SO (k)	H	EE (AVG score above 80%)
SO (l)	H	ME (AVG score between 70% and 80%)

Above graph is showing the average SO is meeting expectations. That is showing that in this course students learning are good.

THE PERCENTAGE OF STUDENTS ACHIEVING THE SATISFACTORY-EXEMPLARY LEVELS IN EACH SO

Following graph represents results between percentages of students achieving satisfactory-exemplary levels in each student outcome.
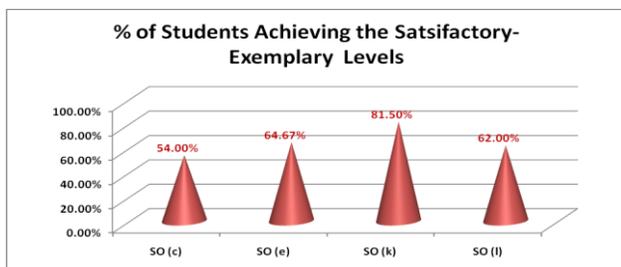

Figure: 4. Percentage of Satisfactory-Exemplary level

Final results criteria are shown in the table based on indirect Assessment.

Table: 4. Attainment criteria of SO

Student Outcomes	Outcome Importance	Final Result (based on indirect assessment)
SO (c)	M	BE (AVG score between 50% and 60%)
SO (e)	H	PE (AVG score between 60% and 70%)
SO (k)	H	EE (AVG score above 80%)
SO (l)	H	PE (AVG score between 60% and 70%)

Above graph is showing the percent of student achieving the satisfactory-exemplary levels for all SO is progress towards except SO(c). That is showing that in this course students learning are satisfactory.

ATTAINMENT OF S O THROUGH DIRECT ASSESSMENT

Table: 5. Attainment of SO via Direct Assessment expectation

Student Outcomes	Outcome Importance	Final Result (based on direct assessment)
SO (c)	M	PE (AVG score between 60% and 70%)
SO (e)	H	ME (AVG score between 70% and 80%)
SO (k)	H	EE (AVG score above 80%)
SO (l)	H	EE (AVG score above 80%)

The summary of the course learning outcomes assisted by the teacher at the end of the course is shown in the table below.

Table: 6. Percent achievement of the students

	Outcome (c)	Outcome (e)	Outcome (k)	Outcome (l)
Planned (Total Marks allocated for each outcome)	16 Marks	32 Marks	32 Marks	20 Marks
Actual (AVG marks obtained by students)	11.12 Marks	24.96 Marks	26.28 Marks	16.37 Marks
% Achievement	69.50%	78.00%	82.13%	81.85%

THE AVG SCORE FOR EACH S O

Direct assessment of attainment of these outcomes by students through exams, quizzes, and project/homework gave the following results:

The final results criteria according to the direct assessment, when using the average score obtained by students, are as follows:

Table: 7. Final results using average score

Student Outcomes	Outcome Importance	Final Result (based on direct assessment)
SO (c)	M	BE (AVG score between 50% and 60%)
SO (e)	H	ME (AVG score above 80%)
SO (k)	H	EE (AVG score above 80%)
SO (l)	H	EE (AVG score above 80%)

THE PERCENTAGE OF STUDENTS ACHIEVING THE SATISFACTORY-EXAMPLARY LEVELS IN EACH S O

We consider the percentage of students achieving the satisfactory-exemplary levels is shown in graph as follows:

The final results criteria according to the direct assessment, when using the percentage of students achieving satisfactory or exemplary levels, are shown in the following table,

Table: 8.Final results criteria based on Direct Assessment

| (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	M
(e)	an ability to identify, formulate, and solve engineering problems	H
(k)	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	H
(l)	the ability to analyze, design, verify, validate, implement, apply, and maintain software systems	H
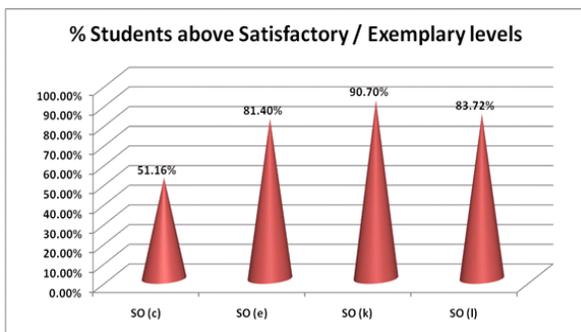
Figure: 5. Satisfactory/exemplary level

Above graph is showing the percent of student achieving the satisfactory-exemplary levels for all SO is progress towards expectation except SO(c). That is showing that in this course students learning are satisfactory.

ANALYSIS OF DIRECT & INDIRECT ASSESSMENT

Summary of the results for both direct and indirect assessment using both the average score as well as the percentage of students achieving the satisfactory/exemplary levels is further explained.

THE AVERAGE OF SCORE FOR EACH S O

The graph for the average score for each student outcome by direct and indirect assessment is shown below:

THE PERCENTAGE OF STUDENTS ACHIEVING THE SATISFACTORY-EXAMPLARY LEVELS IN EACH STUDENT OUTCOME

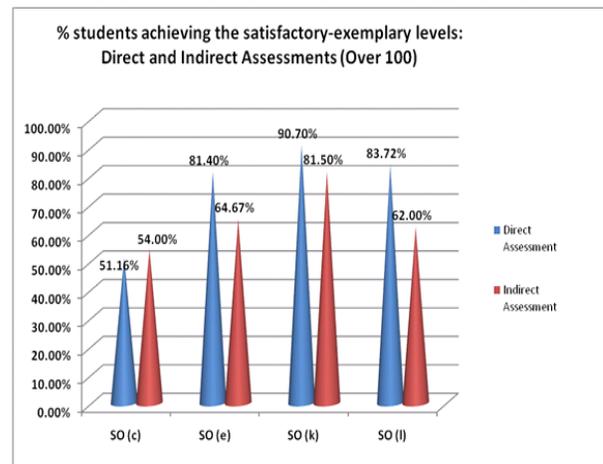Following graph shows the percentage of students achieving the satisfactory-exemplary levels for each student outcome.

Figure: 6. Average score per S O

ATTAINMENT OF STUDENT OUTCOMES

The final results of student outcomes according to direct and indirect assessment is shown in the following table:
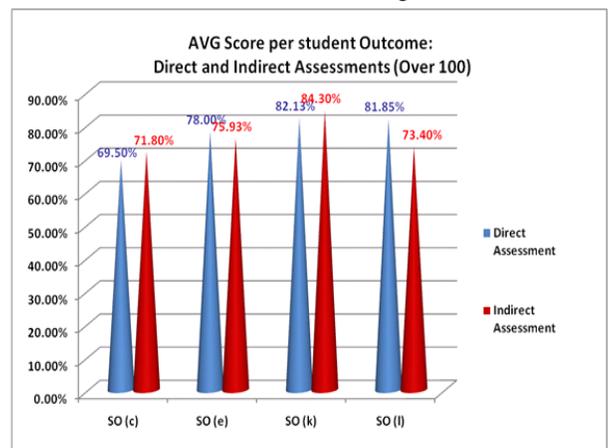

Figure: 7. Direct & Indirect Assessment

Final results are showing that in SO (c) students are not good enough, in SO (e) they are good, in SO (k) they are excellent and exceeding expectations and in SO (l) they are also excellent.

Following sections will explain what main causes for learning were.

LEARNING BARRIERS AND ISSUES

By considering indirect assessment (point of view of students) and direct assessment (point of the teacher), the main issues/barriers are as follows:

- The "Architecture Design" topic was not covered in details as it was assumed that it would be covered in SWE 321 – SOFTWARE DESIGN AND ARCHITECTURE. This was confirmed with the instructor of that course.
- The readiness of the laboratory was another issue. Basically the software tools IBM Rational Software Modeler, was not installed until late in the lab. This had caused delay in the lab work almost for 4 weeks. Consequently this has adversely affected the practical understanding of some important aspects in the course.
- Another problem was that the assigned TAs for the course lacked strong knowledge on RUP and UML which required long time to qualify them before they became professional enough to deliver the course.
- Regarding the clarity of the exam questions, the teacher recognized that some students have difficulties in understanding some English words. This was confirmed when the teacher asked some students after the end of the exam.

PLANNED IMPROVEMENT

We have presented the results to the department advisory board who gave some recommendations that will be converted into actions. These actions will be added to some more actions proposed by the course tutors will be taken in the form of future improvements during the next delivery of the course to resolve the issues mentioned previously. Some of these actions are as follows:

Table: 9. Final Direct & Indirect Assessment

Student Outcomes Covered by the Course	Outcome Importance	Direct Assessment		Indirect Assessment	
		When using the AVG score	When using % students achieving the satisfactory/exemplary levels	When using the AVG score	When using % students achieving the satisfactory/exemplary levels
SO (c)	M	PE	BE	ME	BE
SO (e)	H	ME	EE	ME	PE
SO (k)	H	EE	EE	EE	EE
SO (l)	H	EE	EE	ME	PE

- There is a need to cover topics related to software engineering for complex systems or SoS (System of Systems) like the C4I systems. This was raised by a member of the Advisory Board who claimed there is a high demand country wide on such a type of skills.

- Topics related to the "Architecture Design" have been agreed with instructor of the course SWE 321 – SOFTWARE DESIGN AND ARCHITECTURE and it was agreed that all related topics will be covered in his course.
- The laboratory should not be an issue in the future as all the tools have already been installed. In addition to that we coordinated with IBM to train our technical support specialists on how troubleshoot so that we have sustainable technical support in case some urgent interference is required to fix any software failure.
- Regarding the technical qualifications of the Teaching Assistants in the respective courses they are teaching, it has been agreed with Department Chair to organize three training courses. These training courses have already started in the beginning of the successive semester to make sure TAs are best qualified to conduct the practical lab work.

The course instructor will use his best endeavor to make sure that the exam questions are clear to all students during the exam. Moreover difficult English words will be introduced and translated onto Arabic if necessary during the course. Some students suggested to use electronic dictionary, however this is not preferable as such devices might be used to storing data related to the exam.

CONCLUSION

In this paper, alternative student assessments methods have been proposed and implemented by a Software Engineering department with the purpose of achieving ABET accreditation. The results have been presented, evaluated, and analyzed. As a result of that different learning barriers and issues were identified, and recommendations for future improvements on students learning and course outcomes have been pointed out. The main advantage of the proposed methodology is that it takes into consideration the viewpoints of both the instructors and the recipients, students, using direct and indirect techniques respectively. By comparing the results gained from each approach, the course tutor would have the chance to identify the differences and consequently analyze the causes. The presented methods also proposed two alternative ways of calculating the final results and both are acceptable by ABET. Firstly by using the average of all obtained data and secondly by using a percentage of students achieving the satisfactory-exemplary levels in each student outcome. Those two ways helped the department board set a standard regarding the minimum percentage acceptable for in meeting the department expectations. Further more this work will help others to get ABET accreditation by following our methodology.

FUTURE WORK

In future we are going to generate some kind of automated methods that can help others to use it for generating this kind of graphs and tables through automated system.

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