Planning Only One Assignment to Assess Two of the New ABET Student Outcomes

Introduction

Since the new changes in ABET's student outcomes took effect in Fall 2019, programs have been modifying their assessment plans to address the latest changes. Adopting the new outcomes required program coordinators to review and update their assessment plans in order to ensure efficient and effective assessment. The new implementations provided clarification for some of the outcomes that previously had been vague and difficult to measure. For example, outcome 3(d) "ability to function on multidisciplinary teams" was revised into its new 3(5) outcome "an ability to function effectively on a team whose members, together, provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives" [1]. While the new changes provided better clarification for many of the student outcomes, some of the newly added terms were introduced without a clear definition or explanation. For example, outcome 3 "ability to communicate effectively with a range of audience" did not specify the nature of the "range of audience," e.g., students from other disciplines, professors, or outside observers. Such practice has been followed by ABET in order to give programs the freedom to interpret how the terms will be used and best fit their curricula [3]. Regardless of the used approach or interpretation of terms, an accurate assessment of any of the outcomes requires a careful and thorough design of the performance measures to ensure successful alignment with the outcome.

This paper presents a structure to assess two of the seven new ABET outcomes using one final project assignment in a computer engineering course. The assessment plan uses a group project to evaluate the following outcomes [1]:

- Outcome 3: Ability to communicate effectively with a range of audience
- Outcome 5: An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

In order to facilitate the process, a clear definition of each term was determined before any assessment was done. The assignment used in this study was partitioned into 4 main milestones; each of which was used as a performance metric to assess one or more of the learning outcomes quantitatively. In the paper, we present a detailed description of the assessment method, the evaluation metrics, and the performance indicators used for each outcome. An overall evaluation of the assessment approach will not be discussed in this paper.

Class Format

The Electrical and Computer Engineering department at the author's institution has selected 3 courses to evaluate ABET's (3) and (5) outcomes: EECE 344 "Microprocessor Systems Design," EECE 311 "Electronics," and EECE 498B, the second course in the Capstone sequence. EECE 344, the class used in this study, is a junior-level computer engineering course which all computer, mechatronics, and electrical engineering students are required to take. The class is offered, assessed, then data is collected every semester for electrical and computer engineering students only. Assessing EECE 344 every semester is necessary to be able to capture a satisfactory subset of the low number of computer engineering students in the department. One of the main learning objectives in the class is to train students to collaborate, work in teams, and communicate effectively using oral and written communication. The course learning outcomes are evaluated using a total of 6 lab assignments and one final project assignment. Most of the lab assignments are performed in teams of two (5 out of the 6 assignments), and groups of four-to-five students will work together in the final project assignment. We use the final project assignment only to assess both outcomes (3) and (5) for the ABET accreditation process.

Assessment Plan

The assessment plan used in this class was developed using a carefully selected framework to help structure and organize the assessment process. First, we started by selecting a set of measurable tasks the students should be able to perform and used them as the performance indicators for achieving the SLOs [3] [4]. Outcome (5) provided an explicit definition of three skills to be evaluated in the assessment process: "the ability to provide leadership, establish goals, and meet objectives." This precise definition made it easier to map each outcome to a specific task to be evaluated in the final project.

On the other hand, outcome (3) was provided without a clear definition of the targeted "range of audience," or the communication format, e.g., written, oral, or poster presentation. Therefore, during the planning period, a decision had to be made on how to define the "range of audience" and what form of communication will be used in assessing outcomes (3). Due to the high enrollment in the class, "Oral presentation" was selected as the communication method, and "faculty members from different disciplines and other classmates" was defined as the "range of audience."

Second, we utilized both direct and indirect evaluation tools to evaluate the performance indicators and collect the assessment data. The incorporation of direct and indirect tools was necessary to better assess the development of the students' communication skills as well as group interpersonal skills [3] [4]. The direct assessment was used in evaluating measurable tasks such as meeting deadlines, establishing goals, and meeting objectives. At the same time, the indirect assessment was more suitable in assessing students' ability to work productively with others, their leadership skills, and communication skills [6]. Finally, a set of rubrics was developed to

describe the student's performance level and summarize the assessment's results. The rubrics were generated and organized to directly measure and reflect the students' mastery of each outcome using a variety of performance measures [7]. In the following section, we give detailed descriptions of the performance indicators and rubrics used in the assessment process.

Performance Indicators and Rubrics

Part 1: Learning Objectives and Performance Indicators

The project assignment used in assessing the two learning outcomes was designed where the students needed to spend some time outside of the class and labs working in teams. The project guidelines included several learning objectives that the students were required to demonstrate by the end of the semester. We used direct and indirect assessment measures to evaluate the learning objectives. The following learning objectives were outlined in the project assignment:

- Design, test, and debug a large C program.
- Review the I/O interfacing techniques used in the class and implement at least 3 interfacing methods.
- Plan, design, and implement a system that performs specific tasks.
- Demonstrate the ability to function effectively in teams.

The assessment tools used in the evaluation are summarized in Table 1.

Table 1: Assessment Tools

Student Learning Outcome	Assessment Instrument
(3) Communicate effectively with a range of audiences	Direct Assessment: Faculty evaluation
(5) Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Direct Assessment: Reports, performance, deliverables Indirect Assessment: student evaluations

To be able to assess the learning outcomes, the project description set the structure of the teams and provided a detailed description of:

- Procedure to form teams
- Number of members per team
- Components to be used in the project
- The acceptable platforms to be utilized in the design
- The minimum complexity requirements in the design
- The projects' milestones
- The deliverables associated with each milestone

All teams are required to submit a set of deliverables associated with each milestone. The assessment tools used in this evaluation were planned to assess the students' performance, as well as the group's output. Several individual components were added to the project to evaluate individual learning for all team members. Table 1 shows each milestone with the aligned assessment indicator and the grade distribution. The deliverables grades were used as the evaluation metrics for the corresponding outcomes to ease the assessment process. Milestone 1, 2, 3 (a, b), and 4(a) were used to evaluate SLO (5), and Milestone 3 (c) was used to assess SLO (3).

Table 2: Final Project Milestones Deliverables

Milestone	**Assessment Indicator**	**Grade Distribution**
Milestone 1: a) Submit a detailed description of the proposed design (group assessment). b) Select a team leader for the group (group assessment).	• Provide leadership • Create a collaborative and inclusive environment	10%
Milestone 2: a) Submit a paper outlining each member's task (group assessment). b) A detailed description of each task, including components to be used, design procedure, and timeline (individual assessment).	• Plan tasks • Establish goals	20%
Milestone 3: a) Performance (group assessment) b) Demonstration (individual assessment). c) Oral presentation (individual assessment).	• Meet objectives • Communicate effectively with a range of audiences	50% (20% performance, 20% demonstration, 10% oral presentation)
Milestone 4: a) Project write-up (group assessment). b) Peer evaluation (individual assessment).	• Meet objectives • Create a collaborative and inclusive environment	20% (15% report, 5% peer evaluation)

Part 2: Rubrics

All groups were required to demonstrate their working project at the end of the semester. Students and participating faculty members were instructed to fill out an evaluation form, shown in Table 3, during the demonstration. The demonstration evaluation results were directly used to assess outcomes (3).

Outcome (5) was evaluated using the class instructor's assessment of the milestones, along with a peer evaluation survey, Table 4. The direct and indirect assessments of the milestones were aggregated and summarized to fill out the rubric evaluation forms in Table 5.

Table 3: Student Outcome (3) Rubric Evaluation Forms [7]

Student Outcome 3 Communicate effectively with a range of audiences				
	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exemplary (4)
Technical Contents	Little to no technical contents is used in the presentation.	Overall relevant technical content is low but satisfactory.	The presentation has satisfactory amount of technical content with only a small amount of superfluous information.	Content is sufficient to give the audience a clear account of a challenging technical task.
Effective Language	The level of detail and word usage is inappropriate.	Many items presented are not described sufficiently to allow the intended audience to grasp the much of the presentation.	Most of the presentation is tailored for the intended audience.	The presentation is presented at the correct level of technology and language.
Organization	Presentation cannot be understood due to poor organization.	Audience has difficulty following presentation due to some abrupt jumps; some of the main points are unclear.	Satisfactory organization; clear introduction; main points are well stated.	Superb organization; clear introduction; main pointes well stated and argued; clear presentation of design and conclusion.
Delivery	Not practiced; unsure how to present the design or outcome; distracting gestures; constantly spoke too quickly.	Occasionally spoke too quickly; not always clear.	Clear voice, generally effective delivery; minimally distracting gestures; minor negative issues.	Natural, confident delivery that did convey and enhanced the message.
Handling Questions	Incorrect answers; appears to have very weak understanding of the subject.	Some good answers but also some incorrect ones; evidence of some understanding of subject.	Answers most questions well enough to conclude that the student has a developed good understanding of the subject.	Answers all questions clearly and confidently; gives the impression of having an excellent grasp of the subject.

Student	Technical Contents	Effective Language	Organization	Delivery	Handling Questions

Table 4: Peer Evaluation Form [7]

	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exemplary (4)
Attends group meetings regularly, arrives on time, and contributes to group discussions	Does not attend any group meetings	Attended less than 25% of the group meetings, or attended 50% but always arrive late and does not contribute to the discussion	Attended most of the group meetings and contributed to the discussion most of the time	Always attended the group meetings and contributed to all discussions
Fulfill team role's and duties	Does not perform any duties of the assigned role	Inconsistently performs duties that are assigned	Perform duties that are assigned	Performs all duties assigned and actively assist others
Demonstrate a cooperative and supportive attitude	Always talking, never allows anyone else to speak	Usually doing most of the talking, rarely allows others to speak	Listens most of the time	Consistently listens and responds to others appropriately
Contribute to the success of the project	Always relies on others to do the work	Rarely does the assigned work, often needs reminding	Usually does the assigned work, rarely needs reminding	Always does the assigned work without having to be reminded
Student	Attends group meetings regularly, arrives on time, and contributes to group discussions	Fulfill team role's and duties	Demonstrate a cooperative and supportive attitude	Contribute to the success of the project
Team member 1				
Team member 2				
Team member 3				
Team member 4				

The “Technical Competency” and “Contribution to the team project” performance indicators were determined using the assessment results from deliverables 1, 2, 3 (a, b), and 4 (a). The peer evaluation survey was used to evaluate the rest of the performance indicators. All assessment criteria were shared with the student to ensure a clear understanding of the evaluation process.

Table *5*: Student Outcome (5) Rubric Evaluation Forms [7]

Student Outcome 5 An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives					
Performance Indicators	**1 Unsatisfactory**	**2 Developing**	**3 Satisfactory**	**4 Exemplary**	**Points**
Technical Competency (1)	Inappropriate skillset to support team. Does not work to develop missing skills.	Weak skillset to support team. Begins to develop missing skills.	Has most of skillset needed to support team Develops most of missing skills.	Has almost of skillset needed to support team Develops missing skills in a timely manner.	
Contribution to the team project/work (2)	Does not collect any relevant information; no useful work was done.	Collects information when prodded; offers some ideas to meet team's needs, but not well developed or clearly expressed.	Collects basic, useful information related to the project; occasionally used useful ideas to meet the team's needs.	Collects and presents to the team a great deal of relevant information; offers well-developed and clearly expressed ideas directly related to the group's purpose.	
Take responsibility (3)	Does not perform tasks and relies on others to do the work; often misses meetings. Dies not have anything constructive to say when present.	Performs tasks but needs many reminders; attends meetings regularly but generally does not say anything constructive; sometimes expects others to do his/her work;	Performs all tasks discussed in team meetings, but rarely goes beyond them; attends meetings regularly and usually participates effectively; generally reliable;	Performs all tasks very effectively; attends all meetings and participates enthusiastically; very reliable. Steps in to address shortfalls in team’s activities when needed.	
Value other team members (4)	Often argues, as oppose to having lively discussion, with team mates; doesn't let anyone else talk or acknowledge their contributions to team; occasional personal attacks and "put-downs"; wants to have things done one way and does not listen to alternate approaches;	Usually does much of the talking; does not pay much attention when others talk, often assumes other’s ideas will not work or occasionally takes credit for others work; sometimes patronizing; works reasonably well with only some team members.	Generally listens to others' points of view; always uses appropriate and respectful language; makes an effort to understand others' ideas;	Always listens to others and their ideas; helps them develop their ideas while giving them full credit; always helps the team reach a fair decision.	
				Overall Effectiveness.	

Conclusions

This paper presents a framework to assess two of the seven ABET Student Outcomes using one group assignment. The assignment is designed to evaluate individual students' learning performance as well as the group’s output. Dividing the assignment into several milestones simplified the assessment process and enabled the instructor to assess the students’ learning progress, as well as the final product. It simplified the evaluation of the students' abilities to "establish goals, plan tasks and meet objectives." Furthermore, distributing the assessment measures to several milestones allowed the instructor to identify and target areas for improvement, which should lead to the continuous improvement of the desired learning outcomes. We intend to further evaluate the assessment results in future work and the effectiveness of the proposed assessment plan.

References

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