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Online Course and Program Assessment Strategies Leading to Effective Continuous Improvement

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Dr. Wellman's area of specialization is robotics. Her research focus is on cooperative multirobot systems and sensor networks in search, coverage, and surveillance applications. It also includes using robotics in education. Her research is highlighted in numerous international conference and journal proceedings.

As an educator, researcher, and mentor, Dr. Wellman's overall goal is to continue her research while teaching and training the next generations of computer scientists. One of her favorite inspirational quote is by Marian Wright Edelman: "Education is for improving the lives of others and for leaving your community and world better than you found it."

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Abstract

Due to the COVID-19 pandemic, many universities quickly adapted by switching learning, teaching, and assessment activities from face-to-face to an online environment to enforce social distancing. Faculty had to develop new ways of presenting course content, engaging with students, and providing academic support. Concurrently, administrators had to ensure that accredited programs remain in compliance with their accreditation criteria and policies while in an online teaching/learning environment. As faculty adapted their mode of instruction, they were tasked with ensuring that course learning activities and assessments remain aligned with student learning outcomes. In this paper, the course and program assessment strategies utilized by the Computer Science and Engineering programs at the University of the District of Columbia as they prepared for a virtual accreditation visit will be presented. Examples of performance indicators and rubrics developed to help faculty determine if students are meeting student outcomes will be given, along with (i) systematic procedures for digital collection and evaluation of assessment data, (ii) archiving and well-organized web-based presentation to the accreditation board, and (iii) maintaining effective consultation with advisory boards and program constituents within the constraints of social distancing. We also discuss the surrounding context of aligning college-level outcomes and program objectives with the university-level mission, goals and student learning outcomes and building college-wide consensus and faculty buy-in to the holistic system of assessment and continuous improvement. We conclude that establishing student outcomes and assessment tools are essential in any mode of instruction toward robust, sustained, and effective continuous improvement.

1. Introduction

Many universities quickly adapted by moving learning, teaching, and assessment practices from face-to-face to an online environment to enforce social distancing due to the COVID-19 pandemic. Educational effectiveness has remained an important topic, and academic institutions have developed systems to improve quality. Administrators and faculty had to work collaboratively to ensure quality instruction continued. Faculty had to develop new ways of presenting course material, communicating with students, and offering instructional support [1]. It was the responsibility of the faculty to ensure that learning practices and tests stayed consistent with student learning outcomes. At the same time, administrators had to ensure that approved programs in an online teaching and learning setting were in accordance with accreditation requirements and policies.At the University of the District of Columbia (UDC), all engineering and computer science undergraduate programs follow the Accreditation Board for Engineering and Technology (ABET) [2] standards. Specifically, engineering programs, including civil engineering, electrical engineering, and mechanical engineering, are accredited by ABET Engineering Accreditation Commission (EAC). The computer science and engineering programs are accredited by the ABET Computing Accreditation Commission (CAC) and the ABET Engineering Accreditation Commission (EAC). Based on the ABET accreditation procedure, academic programs must submit a self-study report detailing the strengths of the programs and provide evidence of adherence to the ABET standards every six years. Usually, an onsite visit is conducted for the program after the self-study report is submitted and approved by ABET. However, the global pandemic has affected the normal procedure of onsite accreditation visits [3,4]. Due to the COVID-19, the UDC's engineering and computer science programs went through a virtual ABET accreditation visit in Fall 2020. In this paper, the course and program assessment strategies utilized by the Computer Science and Mechanical Engineering programs at UDC in preparation for a virtual ABET accreditation visit will be presented. Examples of the Computer Science and Mechanical Engineering programs' performance indicators and rubrics developed to help faculty determine if students are meeting student outcomes are given, along with (i) systematic procedures for digital collection and evaluation of assessment data, (ii) archiving and well-organized web-based presentation to the accreditation board, and (iii) maintaining effective consultation with advisory boards and program constituents within the constraints of social distancing. We also discuss the surrounding context of aligning college-level outcomes and program objectives with the University-level mission, goals and student learning outcomes and building college-wide consensus and faculty buy-in to the holistic system of assessment and continuous improvement. We conclude that establishing student outcomes and assessment tools are essential in any mode of instruction toward robust, sustained, and effective continuous improvement.

2. On-line verses Face-to-Face Instruction

When UDC switched to online instruction, UDC's Center for the Advancement of Learning (CAL) provided guidelines and instructions on how to transition to a digital classroom. Faculty were given continuity planning worksheets so they can detail how they will continue teaching and learning activities. Furthermore, looking toward the ensuing summer session and fall 2020 semester, CAL developed a Blackboard-based workshop to train faculty to the level of "Online Teaching Certification" (OTC). This training was made mandatory for all UDC faculty under a newly designated "Emergency Remote Instruction" (ERI) mode. Most faculty utilized virtual conference software and email to continue engagement and communication with learners, moved course materials and submissions to an online management platform, and created and used existing videos and resources to deliver information. In the School of Engineering and Applied Science (SEAS), one of the most important aspects of switching from face-to-face to on-line instruction was to ensure that ABET student outcomes were still being met in the courses. Faculty especially had to address how student outcomes that rely on lab experimentation, student teamwork, and capstone presentations would be demonstrated. For lab experimentation, engineering programs purchased new software to give students a similar experience to being in-person. The computer science program was able to continue to use the same software utilized in the face-to-face instruction. Virtual conference software allowed for students to continue synchronous meetings for teamwork and for the capstone project presentations. The SEAS Director of Student Engagement held weekly meetings with students so they can ask questions and indicate any problems they were having. These meetings also informed faculty of problems that needed to be addressed in courses. Through all these changes, SEAS faculty had to heavily rely on the student outcomes and performance indicators assigned to courses as they developed new learning and teaching activities. This was essential because learning and teaching activities were accessed using the same course assessment process as utilized with face-to-face instruction.

3. Student Outcomes and Performance Indicators

Determining student learning outcomes is a crucial step in maintaining and improving the quality of teaching and learning in education [5]. Student outcomes are the desired qualities that students should possess by the time they graduate. It is recommended that academic programs adopt student outcomes proposed by accrediting bodies. UDC adopted the (ABET) student outcomes, which cover technical and soft skills. The following Student Outcomes have been adopted for the computer science program and are the Student Outcomes recommended by ABET CAC. Graduates of the program will have an ability to:

1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
2. Design, implement and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
3. Communicate effectively in a variety of professional contexts.
4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
5. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
6. Identify and analyze user needs and to take them into account in the selection, creation, integration, evaluation, and administration of computing-based systems.

The following Student Outcomes have been adopted for the mechanical engineering program and are exactly the Student Outcomes recommended by ABET EAC.

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply the engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
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.
6. An ability to develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions.

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

ABET encourages the use of performance indicators in which faculty use to measure student performance to determine whether if a Student Outcome is met. Performance Indicators (PI) are concrete, measurable statements indicating the specific characteristics students need to show for the demonstration of required achievement of the student outcome. It is recommended that a set of performance indicators (PI) be developed for each of the Student Outcomes to guide instructors in the development of course assessments. To address the ABET's emphasis on implementation and assessment of new Student Outcomes for the 2019-2020 cycle, the Dean established an ABET Taskforce comprising all department chairs and one faculty representative from each program in the School of Engineering and Applied Sciences (SEAS). Several ABET Taskforce meetings and faculty meetings were held to discuss the development of performance indicators for the new Student Outcomes. PIs include the use of action verbs that highlight the depth to which students need to demonstrate the performance. The performance indicators for the computer science and mechanical engineering programs are provided in Table 1 and 2; respectively. Performance indicators were mapped to core and elective courses. Table 3 shows the performance indicators mapped to the core computer science courses. The Department of Mechanical Engineering developed a 4-point matrix to evaluate the contribution of each course to each Student Outcome (4 being largest contribution to 1 being marginal contribution). Table 4 illustrates the Student Outcomes for assessment in each course were selected from the outcomes with a rating of 3 (yellow) or 4 (orange), with 4 being preferred. Table 4 also shows the courses and across the cognitive levels of Introductory, Practice and Mastery.

Table 1: Computer Science Student Outcomes and Performance Indicators

Student Outcomes (1) - (6)	**General Performance Indicators** Students Demonstrate Ability to:	
SO1: Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.	SO1-A	Apply mathematical principles (algebra, calculus, and differential equation) and scientific principles to solve complex computing problems
	SO1-B	Develop methods and algorithms to solve complex computing problems
	SO1-C	Estimate time and space complexity of algorithms
SO 2: Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.	SO2-A	Design a computing-based solution using appropriate design tools to meet a given set of requirements.
	SO2-B	Implement a computing-based solution to a computing problem to meet a given set of requirements

	SO2-C	Evaluate a computing-based solution by defining metrics and measuring the performance of the solution that meet a given set of requirements
SO3: Communicate effectively in a variety of professional contexts.	SO3-A	Produce a variety of written documents using appropriate formats and grammar with discipline-specific conventions including citations appropriate to the audience
	SO3-B	Deliver well-organized, logical oral presentations, including good explanations when questioned
	SO3-C	Produce appropriate graphics such as figures, tables in written and oral communications
SO4: Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.	SO4-A	Demonstrate the knowledge of ACM Code of Ethics and Professional Conduct
	SO4-B	Recognize ethical and professional responsibilities of computing solutions and make informed judgments in computing practice based on legal and ethical principles.
SO5: Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.	SO5-A	Participate as a team member or leader in developing and selecting ideas, establishing team goals and objectives, and creating a collaborative and inclusive environment
	SO5-B	Plan collaborative tasks, understand individual responsibility, share responsibilities and information on schedule, and engage in the success of team goals
SO6: Apply computer science theory and software development fundamentals to produce computing-based solutions.	SO6-A	Apply computer science theory, principles and practices learned in various courses to produce a computing-based solution
	SO6-B	Apply software development fundamentals to produce a computing-based solution
	SO6-C	Identify risks of computing-based solutions and describe approaches to manage them

Table 2: Mechanical Engineering Student Outcomes and Performance Indicators

Student Outcomes (1) - (7)	**General Performance Indicators** Students Demonstrate Ability to:	
SO1: An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	SO1-A	Identify complex problems by examining and understanding the issues and necessity of engineering solutions
	SO1-B	Apply mathematical principles (from calculus and differential equations), demonstrate competency of performing analytical and numerical solutions, and appropriately apply scientific principles to model a system or processes
	SO1-C	Develop solution procedures and methods to solve complex engineering problems and identify solutions that are appropriate and within reasonable required accuracy and constraints
	SO1-D	Select and effectively utilize appropriate techniques, tools, and computer-based resources, for a specific engineering task, project, or assignment; demonstrate competency comparing results from alternative tools or techniques
SO 2: An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	SO2-A	Analyze the design problem, develop a clear and unambiguous needs statement, formulate design objectives, identify constraints, and establish criteria for acceptability and desirability of the design solution
	SO2-B	Integrate prior knowledge into design process (such as concept, alternative solution generation, mathematical modeling, computer modeling, evaluation, iteration etc.) to develop engineering solutions
	SO2-C	Explain impact of engineering solution with respect to public health, safety, and welfare, as well as global, cultural, social, environmental, economic, and contemporary critical issues confronting the discipline (i.e., Mechanical Engineering)
SO3: An ability to communicate effectively with a range of audiences.	SO3-A	Communicate effectively in writing in a variety of professional contexts such as lab reports, design reports using appropriate formats and grammar with discipline-specific conventions including citations appropriate to the audience
	SO3-B	Communicate effectively orally in a variety of professional contexts such as well-organized, logical oral presentations, including good explanations when questioned to a range of audiences
	SO3-C	Produce engineering drawings and documents with appropriate graphics such as figures, tables in written and oral communications in a professional manner

Student Outcomes (1) - (7)	General Performance Indicators Students Demonstrate Ability to:	
SO4: An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	SO4-A	Demonstrate knowledge of Professional Code of Ethics in general as well as major/society specific codes (BMES/ASME/IEEE), recognize ethical dilemma, evaluate ethical dimensions of a problem in the discipline, and professional responsibilities in engineering situations to make informed judgements
	SO4-B	Evaluate impact of engineering solutions in global, economic, environmental, and societal contexts and incorporate their sensitivities
SO5: 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	SO5-A	Demonstrate ability to participate as a team member in developing and selecting ideas, establishing team goals and objectives, willingness to take on leadership responsibility and communicate with
	SO5-B	Demonstrate ability to plan collaborative tasks, understand individual responsibility, share responsibilities and information on schedule, and engage in the success of team goals
	SO5-C	Able to develop a constructive team environment (inclusiveness, diversity, conflict resolution and assistance)
SO6: An ability to develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions	SO6-A	Able to develop and conduct appropriate experimentation (identify the assumptions, constraints, models for the experiment, equipment, laboratory procedure and safety protocols)
	SO6-B	Able to analyze and interpret data, validate experimental results including the use of statistics to account for possible experimental error and compares using alternate tools for or methods
	SO6-C	Able to draw conclusions that are supported by the analysis and interpretation of data with respect to assumptions, constraints, and theory
SO7: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	SO7-A	Explain the need for additional knowledge, skills, and attitudes to be acquired independently (self-
	SO7-B	Acknowledge the need for lifelong learning for a professional career by identifying the continuing education opportunities in the profession.

Table 3: AY 2019-20 CS Student Outcomes and Performance Indicators – Core Courses Mapping Matrix

Course #	Course Title	Student Outcomes															
	CORE COURSES	SO1			SO2			SO3			SO4		SO5		SO6		
		A	B	C	A	B	C	A	B	C	A	B	A	B	A	B	C
APCT 110 / 111	Intro to Programming		X		X								X				

APCT 115	Foundations of Computing								X		X	X					
APCT 231/233	Computer Science I Lec/Lab	X	X			X											
APCT 232/234	Computer Science II Lec/Lab	X	X			X											
CMOP 235/236	Webpage Development Lec/Lab								X			X		X			
CSCI 241	Data Structures			X		X									X		
CSCI 306	Computer Ethics & Law							X			X	X					
CSCI 308	Advanced OO Programming	X				X									X		
CSCI 325	Organization Programming Languages			X		X									X		
CSCI 341	Software Engineering							X		X			X	X		X	
CSCI 351	Computer Networks				X		X			X							X
CSCI 410	Theory of Computing	X		X	X												
CSCI 412	Operating Systems		X		X												X
CSCI 415	Computer Organization and Arch.	X				X									X		
CSCI 434	Analysis of Algorithms			X			X										X
CSCI 436	Parallel & Distributed Computing	X	X						X								
CSCI 452	Database Systems Design	X			X	X											
CSCI 498	Senior Project I							X		X			X	X	X		X
CSCI 499	Senior Project II							X	X	X	X		X	X		X	
	Total	**7**	**5**	**4**	**4**	**8**	**2**	**4**	**4**	**4**	**3**	**3**	**3**	**4**	**5**	**3**	**4**

Table 4: Mechanical Engineering Course-Student Outcome-Performance Indicator Matrix

Level	Course #	Course Name	SO1				SO2			SO3			SO4		SO5			SO6			SO7	
			A	B	C	D	A	B	C	A	B	C	A	B	A	B	C	A	B	C	A	B
Introductory Level	CCEN101	Intro to Engineering	X			X	X			X	X	X	X		X		X					X
	MECH107	Mech Engr Computer Graphics	X			X	X	X			X	X										
	MECH108	Programming for Engineers				X												X		X		
	CVEN201	Engineering Mechanics I		X	X																	
	CVEN202	Engineering Mechanics II		X	X																	
	MECH-205	Materials Science					X														X	
	ELEC-225	Electrical Circuits Lecture	X		X		X															
	ELEC-226	Electrical Circuits Lab					X					X				X						
Practice Level	MECH-206	Mechanics of Materials			X				X					X								
	MECH-207	Mechanics of Materials Lab				X				X		X				X			X	X		
	MECH-208	Thermodynamics	X	X	X																	
	MECH-222	Engineering Measurements		X	X			X														
	MECH-224	Engineering Measurement Lab										X						X	X	X		
	MECH-302	Res Exp & Tech Comm								X	X	X	X		X			X		X	X	
	CVEN-308	Applied Numerical Analysis		X	X																	
	MECH-321	Fluid Mechanics		X	X				X	X												
	MECH-322	Thermo & Fluid Lab		X						X					X		X	X	X	X		
	MECH-341	Analysis and Synthesis of Mechanisms	X	X	X		X															
	MECH-351	Heat Transfer		X	X		X	X														
	MECH-361	Machine Design			X	X	X								X							
	MECH-371	Design of Control Systems	X	X							X						X	X	X	X		
	MECH-373	Design of Control Systems Lab				X												X	X	X		
	MECH-381	Microcontrollers in ME		X			X	X														
Mastery Level	MECH406	Engineering Economics							X		X			X								
	MECH-462	Design of Energy Systems					X	X	X	X	X				X	X					X	X
	MECH-465	Advanced Manufacturing					X	X	X													
	MECH-478	Mechatronics	X	X											X	X						
	MECH-483	Robot Mechanics & Control	X		X		X	X	X													
	MECH-487	Photovoltaics	X	X						X	X			X					X	X		
	MECH-488	Fuell Cells				X		X		X	X											
	MECH-491	Senior Design Project I		X			X			X	X		X		X	X	X			X		
	MECH-492	Senior Design Project II				X		X		X	X	X		X		X	X	X		X	X	X
	MECH-495	Special Topics in ME-- Nanotechnology		X	X	X	X	X	X	X		X				X	X	X	X			

4. Digital Collection and Evaluation of Assessment Data

Quality has been an important topic in higher education, and academic institutions have developed various internal and external quality mechanisms to increase quality. For outcome-based programs, appropriate assessments are used to measure the effectiveness of the programs. Strengths and weaknesses of the program can be identified by evaluating the assessment data. Based on the evaluation of assessment data, faculty should discuss strategies to address weaknesses in the academic program. As a result, new performance targets are created to improve the program continuously. At most universities, faculty receive guidance for documentation collection and evaluation of assessment data. Usually, a course portfolio is created for every course in ABET-accredited programs. The portfolio contains syllabi, assessments, and samples of student work.

UDC’s process for assessment, evaluation, and continuous improvement includes collecting and preparing the assessment data for evaluation. We evaluate by interpreting the data acquired through assessment for student performance in our courses each year. This step of our process which we gather assessment data is referred to as Course Assessment. At UDC, one of the most significant changes that were made for the virtual visits was moving all data collection from hard copies to electronic. During AY 2019-2020, Excel-based assessment files were updated with VBA macros to automatically generate course-level assessment rubrics based on the Master Rubrics, tabulate results of the assessment, and aggregate assessment results for all courses in each program.

The Course Assessment Kit contains the following forms:

- Form 1: Course Portfolio Form which includes a description of direct assessment tools (i.e., assignment, quizzes, exams, etc.) that the course instructor select to assess students;
- Form 2: Course Assessment Criteria, which include the appropriate student outcome and performance indictor that are assigned to the course. The instructor also provides course-specific performance indicators and relevant assessment information;
- Form 3: Assessment Rubrics which are developed by faculty;
- Form 4: Student Assessment Score which includes a tabulation of scores for each of the student;
- Form 5: Student Assessment Results, which include the tabulation of scores (on a scale of 1to 4) for each of the performance indicators assigned to the course.
- Form 6: Student Feedback and Continuous Improvement, which include a compilation of direct assessment results and indirect assessment and action to be taken in the next offering

The online Master Rubric system, published to all SEAS faculty on a secure, internal Faculty Assessment Guide website, was an outcome of deliberations by the ABET Task force. A main goal was to relieve faculty of the workload of developing individualized rubrics (especially, detailed descriptions of student-attainment levels: 1 = Unsatisfactory, 2 = Developing, 3 = Satisfactory, 4 = Exemplary) for the assigenents that they used for assessment. Therefore, the ABET Task Force developed a unified Master Rubric with descriptions of levels 1—4 provided for each Performance Indicator. Through Form 2 in the Assessment Kit, a professor could link each assignment used for assessment to a Performance Indicator and thereby “inherit” the descriptions of attainment levels 1—4 from the Master Rubric. The Assessment Kit then automatically compiled the scoring rubric specific to that course in Form 3, and this supported scoring of students using Form 4.

The Computer Science program (CAC) used the Performance Indicators listed in Table 1 as the basis of their Master Rubric. For engineering programs (Biomedical, Civil, Mechanical and Electrical, with EAC), the Task Force further subdivided the Performance Indicators listed in Table 1 into a total 57 more specialized Specific Performance Indicators (e.g., SO1-A-1, SO1-A-2, etc.). Descriptions of levels 1—4 of student attainment were tied to the latter. Having now run the assessment process with both Performance Indicators and Specific Performance Indicators, and benefitting from feedback during the ABET site visit, we intend to dispense with the

Specific Performance Indicators going forward and use the less detailed CS-style Master Rubric (based upon Performance Indicators) for all undergrtaduate programs in SEAS.

Course assignments used for assessment and course portfolios were digitally collected from SEAS portfolios of all assignments and samples of student work were collected from faculty in PDF format using a systematic filename convention. A holistic web presentation system was developed to archive information on all ABET criteria for all accredited programs within SEAS. For efficient implementation, the underlying HTML code was automatically generated using an object-oriented Fortran program. The website, Faculty Guide to Assessment and ABET Preparation, was created to detail the directions for electronically submitting the assessment forms.

Form 4: Student Assessment Scores

COURSE		
	Course No:	CSCI 306
	Course Name:	Computer Ethics and Law
	Instructor :	Briana Wellman
	Term:	Spring 2020

Student	Score for Measure 1 (SO 3-A)	Score for Measure 2 (SO 4-A)	Score for Measure 3 (SO 4-B)
1	4	4	4
2	2		4
3	4		4
4	4	3	4
5	4	4	4
6		3	4
7	4	4	4
8	4	4	
9	3	4	4
10	4	1	4
11			4
12	4	4	4
13	4	3	4
14			4
15	4	3	4
16	3	2	4
17	3		4
18	4	4	4
19	2	4	4
20	3	4	4
21	3	3	
22		3	4

Figure 1: A screenshot of Form 4 of the course assessment form where faculty enter scores for each performance indicator for each student.

Form 5: Results

C O U R S E	
Course No:	CSCI 306
Course Name:	Computer Ethics and Law
Instructor :	Briana Wellman
Term:	Spring 2020

Assessment Measure	Average Score	% ≥ 2	% ≥ 3
1 (SO 3-A)	3.50	100.00	88.89
2 (SO 4-A)	3.35	94.12	88.24
3 (SO 4-B)	4.00	100.00	100.00

General Performance Indicator	Average Score	% ≥ 2	% ≥ 3
SO 3-A	3.50	100.00	88.89
SO 4-A	3.35	94.12	88.24
SO 4-B	4.00	100.00	100.00

Student Outcome	Average Score	% ≥ 2	% ≥ 3
SO 3	3.50	100.00	88.89
SO 4	3.70	97.30	94.59

Figure 2: A screenshot of Form 5 of the course assessment form. This form shows the results that are automatically calculated based on the scores entered by the faculty.

5. Web-based Presentation for Virtual Visit

In past years, ABET has not mandated digital platforms to maintain program assessment documentation [6]. However, academic programs have had to provide accreditation materials in a way that they can be virtually reviewed to enforce social distancing during the pandemic. Therefore, at UDC, a web presentation system was designed to support an effective online evaluation of the ABET virtual visit at UDC. Designing a web-based presentation system is not a simple process. Instead, it is considered a complex process because it requires additional design considerations such as defining the visual appearance and functional design of web pages. For creating a proper webpage, researchers proposed numerous webpage design guidelines or principles. Among them, user-centered design is a broadly known design principle that addresses known weaknesses and limitations in traditional web presentation systems by requiring a deeper understanding of users' expectations and a continuous improvement based on the users' feedbacks. However, since our web presentation system has a specific goal to address the needs of the ABET on-site virtual visit, traditional design guidelines and principles cannot be applicable. Therefore, our web presentation system is designed to provide rich-enough information and materials to support the accreditation evaluation processes of finding necessary (or supportive) statements and evidence materials.

Figure 3 shows a screenshot of the designed web presentation system. It is designed to have multiple menus to show distinctive information on different pages. For designed the system, we defined design guidelines that need to be supported in the system (see Table 5). The design guidelines are defined based on the understanding of the ABET on-site visit requirements. It consists of eight main menus. Figure 3 shows the web-based presentation system. As shown in the figure, it consists of eight main menus. Each main menu provides unique information that is required to provide as part of the self-study report. The web presentation system provides supplementary materials to support the ABET virtual on-site visit. They include collected course materials, student work samples, meeting minutes, and other supportive statements to help the evaluation procedure run seamlessly. As explained above, the system is generated programmatically. Although automatic analysis of collected course-level assessments and student work samples was well designed to create webpages, minor modifications were needed due to the inconsistency of collected materials such as different file types and student samples. For converting different file types and student samples, an additional semi-automatic procedure was considered to parse the materials and create reformatted PDF materials. Specifically, both PHP programming language and Latex (document preparation system) were used.

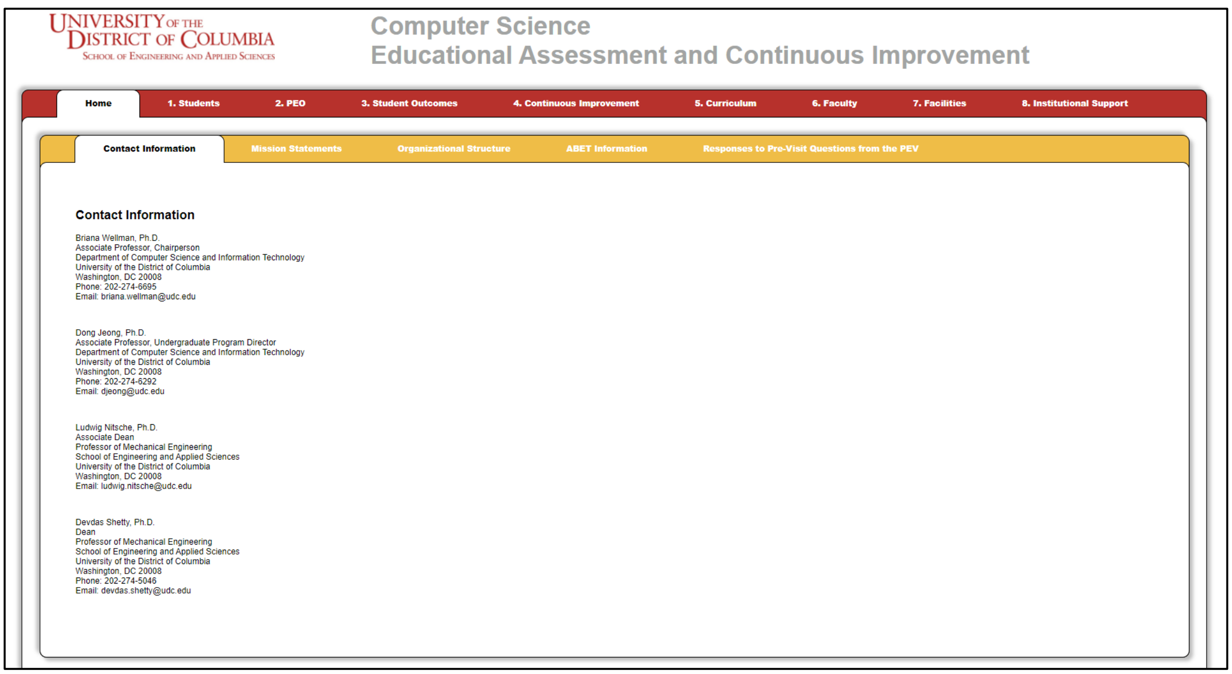

Figure 3. A screenshot of the web-based presentation

Table 5. Design guidelines of web presentation system

Main menus	Sub-menus	Description
Home	Contact Information	List contact persons
	Mission Statement	Provide mission statements of university, school, and department.
	Organizational Structure	Provide the university' structural information
	ABET Information	List ABET program criteria for the program
1. Students	Evaluation at the time of admission	Explain student admission procedure
	Evaluation of Student Progress	Explain student evaluation procedure
	Academic Advising	Explain student academic advising procedure
	Transfer Students and Transfer Credits	Explain transfer students' credits evaluation procedure
2. PEO	Program Educational Objectives	Explain the program educational objectives, including program constituencies
	Establishment of PEO	Explain the procedure conducted for establishing PEOs
3. Student Outcomes	Establishment	Explain the followed ABET student outcomes and their corresponding performance indicators
	Relation to Courses	Explain the transition procedure to follow the new ABET criteria
	Assessment Assignments by Course	Provide all assessment assignments by courses
	Assessment Assignments by Outcome	Provide all assessment assignments sorted by student outcomes
	Student Course Assessment	Provide indirect student course assessment samples conducted by asking topic coverages to students
4. Continuous Improvement	Assessment Procedure	Provide conducted assessment procedures with meeting minutes
	Assessment of Student Outcomes	Provide ABET syllabus as well as direct assessment samples for courses
	Evaluation and Results of Student Outcomes	Provide evaluation results of student outcomes with descriptions
	Course Level Continuous Improvement	List course-level continuous improvements for courses
	Program Level Continuous Improvement	List program-level continuous improvements that include curriculum changes with evidence materials
5. Curriculum	Curriculums	Provide collected course portfolio with student samples
6. Faculty	Faculty Members	List faculty information
7. Facilities	Facilities in the Program	List narrated videos for teaching and research labs
8. Institutional Support	Program Budget and Financial Support	Provide institutional support statements with faculty and staff hiring procedure

Given the compressed nature of ABET site visits and the need to present large amounts of information perspicuously and at multiple levels of detail, one comment about the design philosophy of our digital approach is in order. Available assessment software typically works on the model of a content management system (CMS) wherein both internal preparation (e.g., data collection, uploading of course documents, etc.) and external presentation are merged within the same graphic user interface. Offsetting convenience of the CMS concept, the former (preparative) functionality necessarily impinges on, and to some extent clutters or impedes, the latter (presentational) functionality. Our approach was to separate the two functionalities and optimize the website for the end users: the ABET Program Evaluators and Team Chairs. Despite some additional manual effort on the preparation side, the streamlined web presentation proved worth the effort and was specifically noted for appreciation during the ABET team's report to UDC administration.

6. Maintaining Effective Consultation with Constituents

Program Educational Objectives are broad statements that describe what graduates are expected to attain within a few years of graduation. Program educational objectives of an academic program must be aligned with the mission of the university and the program's constituents' needs. There also needs to be a documented, systematically used, and effective process, involving program constitutes, for the periodic review of these program educational objectives, which ensures that they remain consistent with the institutional mission and the needs of the program's constituents.

We recommend establishing an academic program committee consisting of faculty in the department that can facilitate discussion on the PEOs and present recommendations to the entire faculty. The committee also needs to meet with the remaining constitutes (e.g., administration, advisory board, alumni, students) to review the PEOs for final approval. The committee should establish the timeframe at which to periodically meet to review the PEOs. However, any changes to the school or university mission would necessitate a review of the program's educational objectives.

The periodic review of the PEO must be well documented. We recommend developing an electronic form or survey to gather constitutes review of the PEOs. To involve our program constitutes, we developed a survey using a Qualtrics for reviewing and editing Program Educational Objectives. The survey is used to gather input from constituents and make recommendations for the PEOs. The survey asks constituents to 1) rate the appropriateness of each PEO, 2) propose any addition, suggestion, modification, or reformulation of each PEO, and 3) describe how each PEO relates to UDC's mission, vision, and values (for administrative constituents).

7. Building College-wide Consensus

In navigating ABET accreditation of SEAS within the broader context of University's Middle States accreditation, it is important to (i) align school-wide systems of educational assessment and continuous improvement with university-level principles and activities, and (ii) obtain interdepartmental consensus, faculty buy-in and participation on procedures. These two goals guide and inform strategic planning of assessment and avoid duplication of effort while maintaining both levels of accreditation. Properly mindful of faculty concerns about workload and implementation along with supporting ongoing continuous improvement at course and program levels, school-wide dissemination and training via faculty meetings and web-based tools support faculty buy-in of implementation of assessment procedures [7].

The SEAS Dean established an ABET Taskforce comprising all department chairs and one faculty representative from each program in the School of Engineering and Applied Sciences. Several meetings were organized by the Taskforce during the AY 2018-19 to establish SEAS-wide processes in establishing new Student Outcomes, mapping of new SOs to the course curriculum, developing appropriate, unified performance indicators, and associated assessment rubrics, revision of SEAS-wide continuous improvement of Student Outcomes for all the engineering and computer science programs. During AY 2019-2020 the performance indicators were implemented in an online Master Rubric available to all faculty and assessment procedures were updated with automated Excel-based tools to facilitate course-level assessment and program-level aggregation of results for data-driven planning and decision-

8. Conclusion

The goal of accreditation is to ensure universities are meeting acceptable levels of quality. As universities quickly shifted to online learning and teaching due to the COVID-19 pandemic, many academic programs had to continue to prepare for their accreditation visits. In this paper, the course and program assessment strategies employed for UDC's Computer Science and Engineering programs before and during their virtual ABET visit are discussed. This paper presents (i) systematic procedures for digital collection and evaluation of assessment data, (ii) archiving and well-organized web-based presentation to the accreditation board, and (iii) maintaining effective consultation with advisory boards and program constituents within the constraints of social distancing. In conclusion, we found following ABET guidelines of establishing program educational objectives, making sure they are aligned with the missions of the university, following the program Student Outcomes, and utilizing Performance Indicators to assess whether students are meeting the outcomes is essential in the continuous improvement process in both traditional and online environments. Although the COVID-19 pandemic has added new demands to assessment, evaluation, and accreditation, it has resulted in the creation of more effective and sustainable processes. Future work includes the implementation of a web-based course assessment management system where faculty can upload their course assessments and scores are automatically calculated.

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