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Impact of Intermediate Indicators on Attaining Cognitive Program Outcomes

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Abstract : Globally, engineering education is revolutionizing through the Outcome Based Education (OBE) model. To achieve accreditation under the requirements of the Washington Accord, the Program Outcome attainment has become a focal point in the Engineering field. Attempts to introduce a new OBE-based curriculum in the Universities of Bangladesh have faced many challenges for teaching staff and students. One of the crucial tasks is to achieve the defined Program Outcomes (POs) through Course Outcomes (COs). In this paper, an intermediate relationship between POs and COs is proposed. A case study and analysis of the proposed Intermediate Indicator to attain Cognitive Domain Program Outcomes has been presented to verify the efficiency and effectiveness of the methodology. Results clearly demonstrate that the Intermediate Indicator is essential to attaining program outcomes through course outcomes.

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1. Introduction

Recent trends in Engineering education focus on achieving expertise in Cognitive, Psychomotor and Affective domains as explained in Bloom's taxonomy (Akhmadeeva, Hindy, and Sparrey 2013). Engineering education must confirm that the graduates have the required combined set of skills to face professional challenges, including the ability to address complex problems and social responsibilities (Rao 2015). In recent years, in the era of the internet, engineering education is trending toward enabling students to acquire skills rather than memorizing knowledge. (P. Chaware, & R. Agavekar, 2022) As knowledge is effortlessly available, importance is given to the skill of utilizing knowledge to resolve complex problems. (Raja & Abirami 2022) Hence, Outcome Based Education (OBE), which emphasizes output (learning) instead of only input (teaching), is sweeping engineering education throughout the world (Rajaee et al., 2013). Conventional education is largely restructured to the OBE model all over the world due to its success in modern pedagogy methods for teaching young brains (Spady and Marshall 1991). In Bangladesh, it has also been observed that traditional education should be improved to develop the abilities in graduates such as problem-solving, critical analysis, multidisciplinary project planning, lifelong learning, etc. (Hassan 2012)

In addition to that, engineers must face different nationalities and cultural backgrounds in the global market. Employers are now more interested in quality graduates from the global pool scaled with respect to certain educational standards (Rashid 2013). As a result, an International Engineering Alliance was formed, which later, in 1989, provided the agreement known as the Washington Accord to ensure quality graduates worldwide. The Washington Accord provides the guidelines for the graduate attributes to ensure accreditation to tertiary education programs that qualify graduates for entry into professional engineering practice (International Engineering Alliance 2014). The OBE model has been practiced by 20 countries as a signatory to the Washington Accord, with many other countries working to adopt the method, including Bangladesh (Balaji et al. 2020, Hassan 2012).

Different signatory countries like the USA, UK, Australia, Canada, New Zealand, Japan, Singapore, Korea, Malaysia, India, Pakistan, etc., have started to ensure the benchmark for engineering education in accordance with the Washington Accord. Bangladesh, as the provisional signatory member of the Washington Accord, is required to demonstrate the accreditation system that adopts the graduate outcome standards in tertiary education parallel to the specifications of the Washington Accord (International Engineering Alliance 2014).

The Board of Accreditation for Engineers and Technical Education (BAETE) under the Institute of Engineers—Bangladesh (IEB) conducts engineering program accreditation in Bangladesh. BAETE, therefore, adopts the graduate attributes from the Washington Accord and enlists the twelve Program Outcomes (POs) that describe what graduates are expected to attain after a four-year accredited engineering program (BAETE 2017).

American International University – Bangladesh (AIUB) is always committed to ensuring effective and modern education for students, which is inherited by the Faculty of Engineering, ensuring quality engineering graduates. The four bachelor's program in Electrical and Electronics Engineering (EEE) offered by FE in AIUB is accredited by BAETE. Therefore, in accordance with the accreditation requirements from BAETE, the AIUB EEE department has ensured the proper adaptation of the based curriculum from January 2018 (Spring Semester). To provide Continuous Quality Improvement (CQI), the EEE department has monitored its performance in attaining the POs for five semesters (Spring 2018 to Summer 2019).

Initially, each PO was directly mapped with one or more COs. As the POs include many segments of assessment criteria, it was pretty tricky for the teachers and students to understand the assessment process. Most POs include complex engineering problems or activities, a specific knowledge profile index, and psychomotor and affective domain skills. Hence, most of the time, teachers faced issues in selecting the appropriate assessment tool, resulting in difficulty attaining the PO. To overcome the shortcomings, the department has undertaken the intermediate indexing method to attain the POs from the Fall 2019 semester. In this paper, a comparative study of two assessment methods is presented.

2. Background

American International University - Bangladesh (AIUB) is a government-approved private university where the EEE program has been successfully running for over 20 years. The current curriculum of BSc in EEE at AIUB is focused on the Outcome-based (OBE) teaching-learning process, which has been implemented since the January 2018 Spring Semester. Although the Batch of 18-1 effectively took admission under the new OBE curriculum, the OBE model has been rolled out throughout freshers to final year students to ensure all students go under the OBE model even in an open credit system. The outcomes

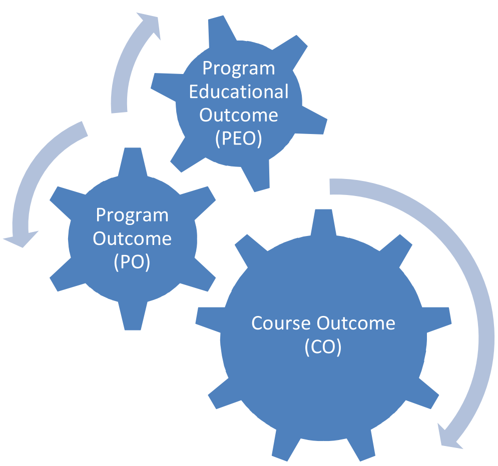

Fig. 1 : Basic OBE Structure

determine the curriculum content, teaching methods, strategies, and the assessment process. The course outcomes (COs) are assessed through different activities such as quizzes, assignments, term examinations, performance tests, lab reports, etc. (Ali, M. Tanseer, Rahman, Md. Abdur, & Lamagna, C. Z. 2021)

As shown in Figure 01, the Curriculum of EEE at AIUB has been modeled after the OBE structure commonly described by the Washington Accord, as described in the BAETE manual (Islam 2017). Program Educational Objectives (PEOs) are statements that describe the expected accomplishments of graduates during their first few years after graduation, which is beyond the scope of this paper. The PEOs are mapped with Program Outcomes Twelve (POs) aligned with the BAETE manual (Islam 2017). Program Outcomes (POs) are narrower statements describing what students are expected to know and be able to do by graduation. These relate to the knowledge, skills, and attitudes that students acquire while progressing through the program. (Dargham et al. 2012) According to the BAETE manual, 12 POs are given as requirements for accreditation, which are effectively derived from WA. According to the description of the 12 POs, they are identified with three corresponding domains of Bloom's Taxonomy (Krathwohl and Anderson 2009), as shown in Figure 02.

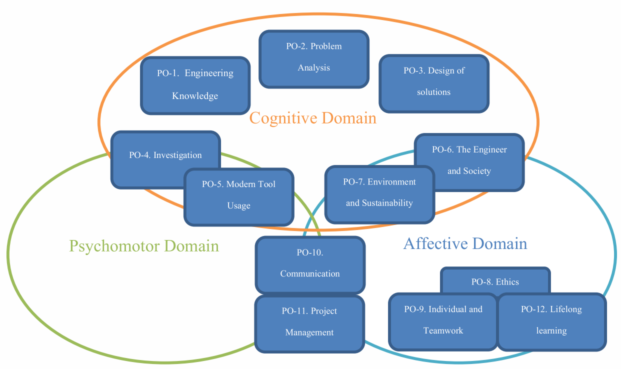

Fig. 2 : 12 POs with Taxonomy Domain

As shown in Figure 2, PO-1: Engineering Knowledge, PO-2: Problem Analysis, and PO-3: Design of Solution predominantly fall within the Cognitive Domain. PO-4: Investigation and PO-5: Modern Tool Usage requires the Psychomotor and Cognitive Domain teaching and assessment. PO-6, "The Engineer and Society," along with PO-7, shares the requirements from both the Affective Domain and Cognitive Domain. PO-10: Communication and PO-11: Project Management falls under the Psychomotor and Affective Domain. Finally, PO-8: Ethics, PO-9: Individual and Teamwork, and PO-12: Lifelong Learning majorly follow the requirements under the Affective Domain. Now, some of the PO statements are abstruse and open to interpretation; their domain must be fixed to relate the knowledge, skills, and attitudes of student outcomes.

Now, these 12 POs will be attained through the Course Outcomes (COs) of different courses throughout the four-year curriculum. As per the guidance of the BAETE manual, the collective COs from all the courses in the program lead to the achievement of the CO to PO mapping. It has been identified that 14 core courses from the EEE undergraduate program are adequate to achieve 12 selected Program outcomes (POs). The EEE department of AIUB then implemented this model in January 2018 (Spring 2018 Semester).

From the very beginning, academic staff at the EEE department of AIUB have faced many challenges in transforming traditional course-based education to an OBE structure, as the immediate course objectives and outcomes used to differ from broader statements of POs.(Akhmadeeva, Hindy, and Sparrey 2013) As one or more COs were aligned to attain one POs, the CO statements were more streamlined and may not fulfill the complete requirements of the PO statements. As a result, many difficulties were found after implementing such direct CO to PO attainment through different assessment methods. Where the actual fulfillment of the POs became the biggest challenge.

In addition to that, the Knowledge Profile (KP), Complex Problem (CP), and Complex Activity (CA), as defined by WA and BAETE, also require COs to attain them. The definitions of KP, CP, and CA are broader and have more options to choose from and set by course and teachers. It was given that the requirements of KP, CP, and CA have to be somewhat attained by the whole curriculum. There was no specific guidance on which COs and POs should assess the levels or options of KP, CP, and CA. However, this limitation was mitigated by the second version of the BAETE manual (BAETE 2017).

The results obtained from the student's achievements from the direct CO to PO also clearly indicated that the achievement of outcomes is vague and misleading. On the other hand, OBE usually requires quantifiable measurements or assessments to justify and prove the attainment of student outcomes (Linsangan et al. 2011).

3. Program Outcome Indicator (POI)

From the above limitations of the direct attainment method of CO to PO, it was apparent that a single CO cannot attain the requirement of POs. Hence, the POs are required to be subdivided into achievable segments. The OBE team has analyzed different approaches to the OBE structure adopted at various countries and universities (Norval 2012; Engineering 2019; Ramchandra, Maitra, and Mallikarjunababu 2015; Rajaee et al. 2013). Finally, the OBE team has proposed an intermediate stage to access the 12 POs through COs, followed by similar approaches in different universities (Faculty of Engineering 2019; Norval 2012). The POs have been subdivided, which are termed Program Outcome Indicators (POI). Hence, the proposed structure for OBE adopted by the Faculty of Engineering in AIUB is shown in Figure 03.

There is another similar concept of performance indicators that is used in other institutes, but there is a significant difference. Although both performance indicators and intermediate indicators are utilized as instruments for program evaluation, their scope and specificity are where they differ most. While intermediate indicators are more focused and intended to track a specific goal, performance indicators are more general and can be connected to various outcomes.

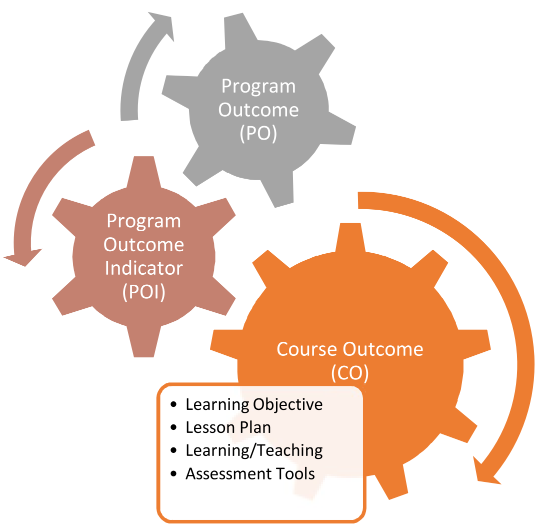

Fig. 3 : Placement of POI

To create the proper effective linkage between COs and POs with the proposed intermediate stage, POI statements needed to address each required segment of PO statements after carefully analyzing and identifying the requirements. In addition, each PO has an indication of assessment tools and pedagogical methods. With the help of Bloom's Taxonomy, POIs have also been labeled with appropriate levels of Cognitive, Affective, and Psychomotor domains. Hence, the structure of the POI code was followed as: P.PO_No.Sub_Part_No.Domain_&_Level; the POI statements derived from the PO statements along with mapping.

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Table 1 : Attainment of Pos Through Cos Directly (without POI)

PO	Course	CO No	CO Statements
PO-1	Digital Logic Design (DLD)	CO1	Demonstrate the use of Number System, Basic Logic Gates, Boolean Algebra, K-MAP, Timing Diagrams of Sequential Circuits
		CO2	Design Digital Systems applying the knowledge of combinational and sequential logic circuit, at gate level.
	Electromagnetic Fields & Waves	CO1	Apply appropriate vector analysis, spatial co-ordinate system and basic calculus to Solve complex engineering problems (analytical).
		CO2	Identify and Apply basic principles of electrostatic theories respectively to the solution of complex engineering problems.
		CO4	Identify and Apply basic principles of Magnetostatics theories respectively to the solution of complex engineering problems
PO-2	Electromagnetic Fields & Waves	CO3	Formulate and Analyze complex engineering problems reaching substantiated conclusions using basic electrostatic theories
		CO5	Formulate and Analyze complex engineering problems reaching substantiated conclusions using basic Time Varying Fields theories.
		CO6	Investigate and Analyze complex engineering problems reaching substantiated conclusions using basic principles of electromagnetic wave propagation.
	Power System Analysis	CO2	Inspect the stability of a power system mathematically, catagorizing it within 6 probable types of faults and discover the fault current and voltage.
PO-3	Electronic Shop	CO3	Design PCB layout of an electronic circuit using suitable tools.
	Microprocessor and I/O System	CO1	Design memory array using linear/ partial/ full decoding techniques based on memory capacity.
		CO2	Design a shifter for the shifting operations given in the function table of a microprocessor.
		CO3	Design an ALU of a microprocessor based on the functions given in the table.

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4. POI Development and Adopted Model

To explicate the key concept of POI, this paper has focused on cognitive domain POs, i.e., PO-1, PO-2, and PO-3, as shown in Figure 02. Hence, the attainment of PO-1, PO-2, and PO-3 with and without POI has been presented with the student achievements to justify the efficiency of POI implementation to achieve POs through COs with the help of POI. The cognitive domain PO statements are given as follows:

A. PO1

Apply knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialization as specified in KP1 to KP4, respectively, to the solution of complex engineering problems.

B. PO2

Identify, formulate, research literature, and analyse complex engineering problems, reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences (KP1 to KP4).

C. PO3

Design solutions for complex engineering problems and design systems, components, or processes that meet specified needs with appropriate consideration for public health and safety and cultural, societal, and environmental considerations. (KP5).

Initially, without POI, the PO-1 was attained by two courses, Digital Logic Design (DLD) and Electromagnetic Fields & Waves. In contrast, PO-2 had been attained with Electromagnetic Fields & Waves and Power System Analysis. Finally, PO-3 was assigned to the Electronic Shop, Microprocessor, and I/O System. The Faculty of Engineering in AIUB academic staff were given in-depth training for the OBE Model, Pedagogy method, and Assessment techniques. In addition to that, the CO statements and questionnaire were formatted using Bloom's Taxonomy and action verbs. Aligning with the PO statements, each teacher of a specific course developed the CO statements to attain the POs directly through COs. The course teachers independently and collectively created the attainment methods and assessment tools of COs. The CO statements aligned with PO-1, PO-2, and PO-3 have been presented in Table I.

It is apparent from the CO statements that the teachers of different courses have aligned with parts of the PO statements to attain student outcomes. However, the statement of PO-1 and PO-2 is required to attain four components of Knowledge Profile (KP), i.e., knowledge of - (i) mathematics, (ii) natural science, (iii) engineering fundamentals, and (iv) engineering specialization. Most of the CO statements aligned with PO-1 are mainly focused on knowledge of engineering fundamentals. Similarly, the COs assigned to attain PO-2 predominantly emphasize mathematical calculations and engineering fundamentals. Finally, PO-3 was required to achieve level 6 cognitive domain, i.e., "Design," which is merely met by CO statements but completely ignores the vital part of designing engineering solutions preserving the health & safety of the public and the environment. In addition, PO-1, PO-2, and PO-3 are also required to fulfill the requirements of the Complex Problem (CP) Definition, which none of the CO statements mentioned.

Hence, it was apparent that an intermediate level was necessary to create the linkage between COs and POs. The proposed structure, PO-1 and PO-2, has been subdivided into four parts for each POs: P.01.1.C3, P.01.2.C3, P.01.3.C3, P.02.1.C4, and so on. All POIs of PO-1 are "Apply" level, hence cognitive domain level 3, i.e. C3. Similarly, PO-2 has been a

Table 2 : Poi Statements And Kp,cp Mapping

POs	POI Code	POI Statement	KP	CP
PO-1: Engineering Knowledge	P.01.1.C3	Apply information and concepts in *natural science* with the familiarity of issues.	KP-1	
	P.01.2.C3	Apply information and concepts of *mathematics* to solve complex engineering problems with a range of conflicting requirements.	KP-2	CP-1, CP-2, CP-6
	P.01.3.C3	Apply information and concepts in *engineering fundamentals* with the familiarity of issues.	KP-3	
	P.01.4.C3	Apply information and concepts in *specialized engineering sciences* with the in-depth of analysis of a complex engineering problem.	KP-4	CP-1, CP-3, CP-7
PO-2: Problem Analysis	P.02.1.C4	Identify and relate first principles of mathematics, natural sciences and engineering sciences to solve complex engineering problems.	KP-1, KP-2, KP-3	CP-1, CP-2, CP-6
	P.02.2.C4	Formulate solutions, procedures, and methods to solve complex engineering problems		CP-1, CP-4, CP-5
	P.02.3.C4	Analyze and solves complex engineering problems reaching substantiated conclusion	KP-4	CP-1, CP-2, CP-6
	P.02.4.C5	Research literature and Critically evaluates the validity and accuracy of existing solution methods using specialized engineering knowledge.	KP-4	
PO-3: Design/ development of solutions	P.03.1.C2	Identify the different components or processes of complex engineering problems.		CP-1, CP-3, CP-7
	P.03.2.C3	Develop solution for different components of complex engineering problem.		CP-1, CP-3, CP-7
	P.03.3.C4	Develop probable solutions that meet specified needs with appropriate consideration for public health and safety, culture, societal and environmental considerations.	KP-5	

requirement for Cognitive Domain Level 4, i.e., the "Analyze" level, and hence C4. For PO-3, cognitive domain level 6, i.e., "Create", hence C6 has attached with the POI code as shown in Table II.

Giving the specific cognitive domain code with POI can prevent confusion about teaching, learning,

Table 3 : Poi Based Cos

POI	Course	COs Aligned with POIs
P.01.3.C3	Electrical Machines – 1	CO3: Apply information and concepts in basic Electrical Machines with the familiarity of issues
	Electronic Devices	CO2: Apply information and concepts in engineering fundamentals with the familiarity of issues.
P.01.4.C3	Industrial Electronics and Drives	CO3: Apply information and concepts in specialized engineering sciences with the in-depth of analysis of a complex engineering problem.
	Analog Electronics	CO4: Apply information & concepts in specialized engineering sciences with the in-depth of analysis of a complex engineering problem
P.02.1.C4	Electromagnetic Fields and Waves	CO5: Identify and relate basic principles of electromagnetic wave propagation to solve complex engineering problems
	Modern Control System	CO1: Identify and relate first principles of mathematics, natural sciences and engineering sciences to address complex engineering problems.
P.02.2.C4	Digital Signal Processing	CO3: Formulate solutions, procedures, and methods to solve complex engineering problem.
	Digital Logic Circuits	CO3: Formulate solutions, procedures, and methods to solve complex engineering problems using concept of digital logic and circuits at gate and transistor level.
P.02.3.C4	Power System Analysis	CO3: Analyze and solves complex engineering problems reaching substantiated conclusion.
	Electrical Machines – 2	CO5: Analyze and solves complex engineering problems reaching substantiated conclusion
P.02.4.C5	Capstone Project	Research literature and Critically evaluates the validity and accuracy of existing solution methods using specialized engineering knowledge.
	Telecommunications Engineering	CO1: Identify and relate first principles of mathematics, natural sciences and engineering sciences to solve complex engineering problems.
P.03.1.C2	Power System Analysis	CO4: Identify the different components or processes of complex engineering problems.
	Elec. Power Transmission and Distribution	CO1: Identify different parameters, components or process of high level complex engineering problem related to electrical power transmission and distribution systems.
P.03.2.C3	Modern Control System	CO2: Develop solution for different components of complex engineering problem.
	Electrical Machines 2 Lab	CO1 Develop solution for different components of complex engineering problem
P.03.3.C4	EEE Services Design Lab	CO1: Develop probable solutions that meet specified needs with appropriate consideration for public health and safety, culture, societal and environmental considerations.
	Power Stations and Substations	CO4: Develop probable solutions that meet specified needs with appropriate consideration for public health and safety, culture, societal and environmental considerations

and assessment levels. The course coordinators of each course were given specific instructions and training in order to modify CO statements to be aligned with the particular POIs. The updated CO statements were properly evaluated with the given criteria and reviewed by the OBE team. The updated mapping for attaining PO-1, PO-2, and PO-3 with the courses and their statements are given in Table III. Each POI was assigned to two appropriate core courses to attain.

From the above updated CO statements aligned with the POI model, we may attain a more accurate PO-1 collectively. In addition to that, most teachers considered OBE-based cognitive domain assignments to assess the CO through assignments as the specific requirements and complexity to support the related knowledge profile (KP), complex problem (CP), and complex activity (CA) definitions. In addition to PO-1, attainment also requires meeting the requirements of Knowledge Profile (KP), Complex Problem (CP), and Complex Activity (CA) as per definitions provided by WA as well as BAETE. For example, P.01.1.C3, the first part of PO-1, has been aligned with KP-1, while the second part, P.01.2.C3, has been aligned with KP-2, CP-1, CP-3, and CP-4. The detailed analysis and attainment of KP, CP, and CA are beyond the scope of the paper, but it is crucial to mention that the proposed POI model also makes it straightforward to attain the requirements of KP, CP, and CA through COs.

5. Assessment Tools, Results and Analysis

Academic staff has been given specific POIs to attain through their courses, and the updated model has been successfully implemented from the Fall 2019 semester. Now, to analyze the students' performance in attaining the first PO, which focuses on "Engineering Knowledge," has been considered as sample attainment and presented in this paper. The sample data is presented in Figure 04, where the PO-1 achievement rate for one semester of Summer 19 without POI.

The course "Electromagnetic Fields and Waves (EMFW)" was selected to attain PO-2 in Summer 19 (without POI) and then updated to attain POI P.02.1.C4 only during the Fall 19 semester. Hence, the assessment tools set for the course EMFW are the best sample to explain the effectiveness of the implementation of POI. First, the following questions were given as Assignments to achieve CO6, i.e., the ability of students to investigate and analyze complex engineering problems, reaching substantiated conclusions using basic principles of electromagnetic wave propagation. The Course outcome CO6 were carrying 33٪ marks to attain PO-2.

Table 3: Poi Based Cos

POI	Course	COs Aligned with POIs
P.01.1.C3	Electrical Circuits – 1 (DC)	CO1: Apply information and concepts in basic electrical properties and atomic structure of materials, flow of charge, effects of temperature on resistance of a material, etc. with the familiarity of issues to calculate different electrical parameters in circuits containing DC source
	Electrical Properties of Material	CO5: Apply information and concepts in natural science with the familiarity of issues
P.0 1.2. C3	Electrical Circuits – 2 (AC)	CO3: Apply information and concepts of mathematics to solve complex engineering problems in Alternating Circuits with a range of conflicting requirements.
	Signal and Linear System	CO5: Apply information and concepts of mathematics to solve complex engineering problems with a wide range of solutions

Question 01: Given a wave for which $\vec{E_S} = 15e^{-j\beta z}\hat{a}_x + 15e^{-j\beta z}e^{-j\varphi}\hat{a}_y$ V/m in a medium characterized by complex intrinsic impedance, η (a) find $\vec{H_S}$; (b) determine and analyze the average power density in W/m^2.

From the above question as an assignment, it has been observed that the assessment tool only requires a mathematical solution applying the electromagnetic wave propagation theory. Although the question involves an analysis of the solution in the second part, there are no specific requirements or instructions. The assessment tool completely misses the Complex Engineering Problem (CP) requirements in the PO-2. So, it is apparent that these types of questions and assessment tools are not adequate to attain the requirements of PO-2 directly from CO6 of the EMFW course. Another crucial part of PO-2 was the ability to "reach a substantiated conclusion," which has been entirely ignored by the question and the COs of the course EMFW.

Now, after introducing the POI concept to the course teachers of EMFW, they have been given the requirements of POI – P.02.1.C4, which requires to demonstrate the student's ability to identify and relate the first principles of mathematics, natural sciences, and engineering sciences to solve complex engineering problems. For complex engineering problems, CP-1, CP-3, and CP-7 were also assigned to be attained by the CO. The faculty members of the course have developed an updated assignment as the assessment tool for the POI. The following is the part of the assignment,

Question 02: The students of Fields and Waves are asked by the university to analyze and recommend the safety of the people who move surrounding the following lab rooms that contain the components individually in different areas such as:

(i) the air space at a point within a large power distribution transformer where
$\mathbf{B} = 0.8\ cos[1.257\times10^{-6}(3\times10^{8}t- x)]\mathbf{a}_y$ T;
(ii) within a large, oil-filled power capacitor where $r = 5$ and
$\mathbf{E} = 0.9\ cos[1.257 \times 10^{-6}(3 \times 10^{8}t - z\sqrt{5})]\mathbf{a}_x$ MV/m;
(iii) in a metallic conductor at 50 Hz, if $\varepsilon = \varepsilon_0$, $\mu = \mu_0$, $\sigma = 5.8\times10^{7}$ S/m, and
$\mathbf{J} = sin(377t - 117.1z)\mathbf{a}_x$ MA/m^2 ;
(iv) an automobile antenna where the magnetic field intensity of an FM signal is
$H_x = 0.15\ cos[3.12(3 \times 10^{8}t - y)]$ A/m.
The analysis should include the radiated power density calculation for the following scenarios, whether they are safe for people or not. Provide necessary comments that will ensure a healthy concern for the different university stakeholders moving around the zone.

The analysis should include the radiated power density calculation for the following scenarios, whether they are safe for people or not. Provide necessary comments that will ensure a healthy concern for the different university stakeholders moving around the zone.

From the requirements of PO-2, it is apparent that the above sample question from the EMFW course fits more accurately to attain POI through CO and then results in attaining PO-2. The question requires students to "Identify and Relate" the first principles of engineering science with mathematical calculation, which requires in-depth knowledge of KP-1, KP-2, and KP-3. The question also addresses the complex problem requirements with CP-1: in-depth knowledge of electromagnetic wave theory, CP-2: wide range of engineering issues in different equipment in the lab, and CP-6: involves stakeholders as it requires students to provide an analysis of the safety of the lab environment. Hence, a single assignment problem fulfills the specific requirements of PO-2 along with KP and CP.

Previously, while the course EMFW had given the responsibility to attain the complete requirements of PO-1 and PO-2, the excessive load undoubtedly failed to fulfill the requirements. After implementing the POI model, the load from the single course can easily be distributed in different courses, ensuring specific criteria from POs can be achieved. For the attainment analysis of CO and PO, holistic methods are considered, unlike different average attainments in various universities. (Anisa et al. 2009; Ramchandra, Maitra, and Mallikarjunababu 2015; Terang, Bisoyi, and Chandna 2015). Therefore, if a student can secure more than 60% marks by combining all OBE components under a specific CO, then the student is

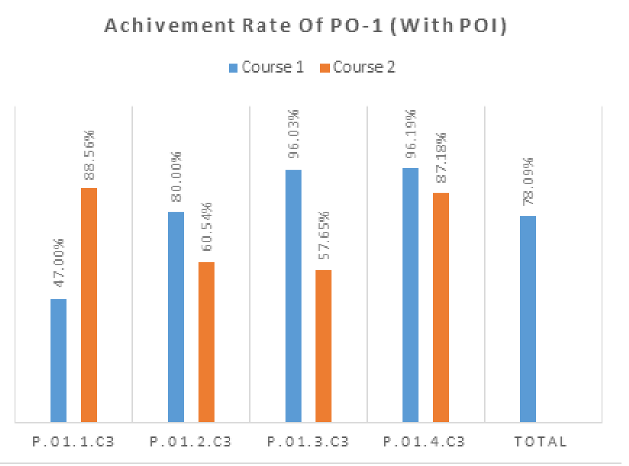

Fig. 5. : Achievement Rate of PO-1 With POI.

considered to have achieved the CO. If one PO has been achieved by the student in one course, then attainment in another course for the same PO is not considered.

To provide the effectiveness of the POI system, the student performance on PO-1 has been presented in this paper both prior to the POI model introduced (Summer 2019) and after the effect of POI implementation (Fall 2019). From the student performance during the Summer 2019 semester, as shown in Figure 04, it can be observed that the students were struggling to achieve the course outcome. As a result, the attainment of PO-1 was unsuccessful. The sample size is a class of 40 students and four sections per subject, a total of 160 students. A secondary reason for the failure can be that there are too many trivial components to achieve CO, resulting in unmanageable assessments from both faculty and student perspectives. So, it can be concluded from the data that the assessment tools were inadequate to measure the PO requirements.

Conclusion

A preliminary stage of the OBE implementation structure for PO-1 attainment has been discussed with the case study at AIUB in Bangladesh. Here, an intermediate stage of PO attainment through CO has been studied, and the case study with results has been presented to demonstrate the effectiveness of the adopted method.

The results show that the Program Outcome Indicator (POI) can be a major tool for creating a linkage between PO and CO for better understanding and attainment for teachers and students, respectively.

Academic staff and Students in the Faculty of Engineering at AIUB have embraced this new method and achieved it with great success. Complementary components of the complete OBE model adopted at AIUB will be published in successive research works.

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