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An Assessment of the Program Outcome (PO) Scores for Fluid Mechanics 1 (MEC441) Obtained from the Exit Entrance Survey (EES)

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Abstract: *The assessment of program learning outcomes for the purpose of continuous quality enhancement and evaluation has attracted considerable global attention within higher educational institutions. This is attributable to the fact that student evaluations possess the capacity to elevate the quality of education and the learning outcomes associated with specific courses. This article investigates the attainment of Programme Outcomes (PO) for the Fluid Mechanics 1 course undertaken by Bachelor of Mechanical Engineering students at UiTM Shah Alam. This research employs data derived from 86 students who enrolled in the MEC441 course for the October 2023 – February 2024 semester. In order to assess the level of achievement, an Exit Entrance Survey was utilized to juxtapose student responses regarding analogous questions posed at both the commencement and conclusion of the semester. Among the eleven Programme Outcomes delineated by the Engineering Accreditation Council (EAC) for the engineering curriculum, three outcomes—specifically PO1, PO2, and PO3—were associated with this course. The cognitive dimensions represent the focal point of the knowledge domain pertinent to these three POs. Additionally, the attainment of POs was evaluated against a threshold of 65%, which is stipulated as the program's achievement requirement. The findings suggest that entry-exit surveys serve as a viable method for capturing students' perceived achievement of the targeted learning outcomes, thereby offering insights into the formulation of course evaluation strategies in a broader context. Survey results indicated that more than 60% of students demonstrated outstanding performance in Course Outcome 3 (CO3), achieving ratings classified as "excellent," "very good," and "good.". Furthermore, over 90% of students surpassed the satisfactory level in Program Outcome 3 (PO3). Conversely, the findings indicate a discrepancy between the assessments of PO1 and PO2 and the student perceptions expressed in assignment, test, and final examination evaluations. A variety of reflective methodologies were recommended to enhance the conditions pertaining to CO1:PO1 and CO2:PO2.*

Keywords: OBE, Entrance-exit Survey, Program Outcome (PO), Course Outcome (CO)

1. Introduction

An Entrance Exit Survey (EES) represents a crucial component of the evaluative framework that will be examined within the context of the Closing of the Loop (CDL) at Universiti Teknologi MARA (UiTM). The EES serves to collect insights from students about the specific

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course codes they engage with at the start and end of an academic semester. This survey is administered for UiTM scholars through the UFUTURE platform, which is also widely used for online pedagogy and learning. Fluid Mechanics 1 (MEC441) is classified as a mandatory subject within the primary course category for undergraduate students enrolled in the School of Mechanical Engineering, College of Engineering, UiTM. However, enrolment of this course are excluded for students who are approved for credit transfer (because they have taken an equivalent course during their diploma). Course Outcomes (CO) information for each course will be updated by the Resource Person at Academic Information Management System (AIMS). Based on the course information used on semester October 2023 – February 2024, there are three COs set for MEC441. For students who register for course, CO1 stated that at the end of the course, they are expected able to explain the basic concepts and principles in Fluid Mechanics. Besides CO2 set for the student able to analyse problems in fluid statics, control volumes, model studies and viscous flows in pipes and ducts and for CO3, the student able to develop solution for fluid mechanics problems related to model studies and viscous flow in pipe and ducts.

This article presents an analysis of the EES survey data to evaluate the attainment of the COs established for course MEC441. In addition, this study will also analyse which COs have the best achievements. The objective also to ascertain whether the students' perception of their mastery of the learning outcomes was reflected in their assessment scores as a result of the teaching learning process. The evaluation of this CO's achievement for MEC441 was based on the EES of for Bachelor degree students in the School of Mechanical Engineering, College of Engineering, UiTM who numbered 86 people in Semester October 2023 – February 2024.

2. Literature Review

The learning outcomes for engineering degree programs are crucial in preparing graduates for success in a competitive global landscape. These outcomes are often aligned with the International Engineering Alliance's graduate attributes, which serve as benchmarks for global competencies in engineering education (Soeiro & Falcão, 2013). A prevalent approach in engineering education is Outcome-Based Education (OBE), which focuses on the attainment of specific course outcomes (COs), program outcomes (POs), and program-specific outcomes (PSOs) (Hamidi et al., 2024). OBE involves structured course design, instructional delivery, and assessment methods to ensure that these learning outcomes are met (Bhagyalakshmi et al., 2015). Various assessment methods, both direct and indirect, including reflective reports, are employed to evaluate the attainment of these outcomes, providing essential feedback for continuous improvement (Liew et al., 2022). However, challenges persist in the implementation of OBE, such as data collection and faculty commitment, which can hinder the effective attainment of learning outcomes (Bhatti et al., 2023). Addressing these challenges is vital for improving educational practices and ensuring that engineering graduates are not only technically proficient but also equipped with critical thinking, problem-solving, and effective communication skills necessary for their professional success. Therefore, it is essential to undertake a comprehensive analysis of student evaluations, as these evaluations serve as a crucial mechanism for enhancing the learning experience of the students themselves.

The Engineering Accreditation Council (EAC) is recognized as the official governing body tasked with the accreditation of Bachelor of Engineering programs offered by Institutions of Higher Learning (IHLs). The accreditation process for these engineering programs permits graduates to formally register with the Board of Engineers Malaysia (BEM), in accordance with the provisions set forth by the Registration of Engineers Act 1965 (Revised 2002). BEM

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is tasked with the responsibility of ensuring that the quality of engineering education and programs for its registered engineers meet the minimum standards that are comparable to global practices, thereby necessitating the accreditation of engineering programs offered in IHLs (BEM, 2020). The EAC has introduced the Outcome Based Education (OBE) framework, which represents an educational approach wherein the developed curriculum is guided by the outcomes that students are expected to demonstrate by the conclusion of the program. The implementation of OBE is in accordance with the Washington Accord agreement, which was ratified in 2003. According to this accord, all engineering programs offered in participating countries will be acknowledged, provided they fulfil all requisite components. Among these components is the OBE implementation, which necessitates Continuous Quality Improvement (CQI) not only in teaching and learning but also encompassing curriculum design.

Course Outcomes are explicit statements outlining the knowledge and competencies students are anticipated to achieve and demonstrate by the end of the course. The student attributions within the Course Outcomes are systematically categorized in accordance with the learning domains outlined in Bloom's Taxonomy, namely; Cognitive, Affective, and Psychomotor domains. The CO-PO matrix is used by School of Mechanical Engineering, UiTM to establish a connection between program and course outcomes within the curriculum framework. Consequently, each course offered is associated with its respective CO-PO matrix. Furthermore, at UiTM, an Entrance Exit Survey (EES) is component of the analysis that will be assessed in the Closing of the Loop (CDL). EES surveys employ similar questions administered at the beginning and end of a course or curriculum program. The EES question with 5 Likert scales was designed based on the syllabus content of the course, and each related question has been mapped to the respective PO.

The purpose of this paper is to analyze the correlation between the application of EES and student performance in Fluid Mechanics 1, considering predefined program objectives. The surveys are mandatory for all enrolled students and are to be completed via the official online learning platform of the University, UFUTURE. For the purpose of analysis, the Fluid Mechanics 1 course has been chosen, which is undertaken by first-year Bachelor's students at the School of Mechanical Engineering, Universiti Teknologi MARA.

3. Research Methodology

In the beginning of the semester, students have to answer a few questions in EES which set by the resource lecturer (resource person) of the course. At the end of the semester, the same question asked to assess to what extent the students achieved the target in Course Outcomes (CO). Each question will be answered by students with a value of 1 for strongly disagree, 2 for disagree, 3 for mixed feeling, 4 for agree and 5 for strongly agree. Based on EES, the survey system will determine the CDL value for each student. The gap value will be calculated by getting the difference score for Exit Survey minus score for Entrance Survey. If a gap value equal to 4 indicates "excellent" achievement and a value of 3 means "very good'. If EES survey by the student shows gap value equal 2 it means "good", a value of 1 means "fair" while if the gap value is 0 It shows the achievement is "poor" (Curriculum Affairs Unit-UITM, 2015).

The EES data involved 86 students who took MEC441, Semester October 2023-February 2025. The data were retrieved from the UFUTURE system. Following this, a descriptive analysis was performed to ascertain frequencies and percentages. These EES questions are linked to each topic in the curriculum. Table 1 shows the EES question related to the respective POs, Course topics and taxonomy domain. The first EES questions linked to PO1, whereas EES questions

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2 is mapped to PO2. The EES questions for PO3 is from EES question 3 as detailed in Table 2.

Table 1: The mapping of Fluid Mechanics 1 course POs with EES question

EES question number	MEC441 Topic covered	PO1	PO2	PO3
		Cognitive	Cognitive	Cognitive
1	1	√		
2	1, 2, 3, 4, 5		√	
3	4, 5			√

Table 2: The EES question for MEC441 Fluid Mechanics 1 course

EES question number	EES List of question
1	I am able to explain basic concepts and principles in Fluid Mechanics
2	I am able to analyze problems in fluid statics, control volumes, model studies and viscous flows in pipes and ducts
3	I am able to develop solutions for Fluid Mechanics problems related to model studies and viscous flow in pipes and ducts

The domain of evaluation and the methodology of assessment established to quantify Course Outcomes (CO) have been determined by the appointed Resource Person (RP) for the course and are mandatory for compliance by all lecturers under the same course. The RP also shall standardize the proportional weightage of all assessments. Within the parameters of this course, CO1 shall be assessed in Assignment 1 and the Final Examination, which carry weights of 10 and 15 marks respectively. CO2 shall be evaluated through a Test and the Final Examination, which carry weights of 10 and 45 marks respectively. A collaborative marking system has been implemented for both assessments to ensure consistency within the marking framework and to reduce the likelihood of biases during the evaluation process. For the assessment of CO3, two individual assignments were conducted, contributing a total of 20 marks. The aggregate score for CO1, CO2, and CO3 is conclusively set at 100%.

4. Results and Discussions

The outcomes are derived from the Entrance-Exit Survey (EES) results, which were employed to evaluate the effectiveness of pedagogical processes and learning experiences through a self-assessment methodology conducted by the students. Furthermore, the comprehensive evaluation at the conclusion of the course encompasses cognitive evaluations achieved through assignments and examinations. The analyses conducted on the EES and ongoing course assessments are systematically aligned with the Course Outcomes: Program Outcomes matrix.

Under the Program Learning Outcome 1 (PLO1) and Cognitive 2 (C2) set by School of Mechanical Engineering, UiTM, one of the targets of Course Learning Outcome (CO) for MEC441 is the students can explain basic concepts and principles in Fluid Mechanics. There are three (3) POs connected to the Cognitive element: PO1 on knowledge, PO2 on problem analysis, and PO3 on solution design/development. Figure 1 depicts the frequency score of EES for questions that dedicated to access PO1. The PO1 evaluate knowledge gained during the course learning process. The scoring is moderately distributed for each question where approximately 60 % frequency score in between 2, 3 and 4.

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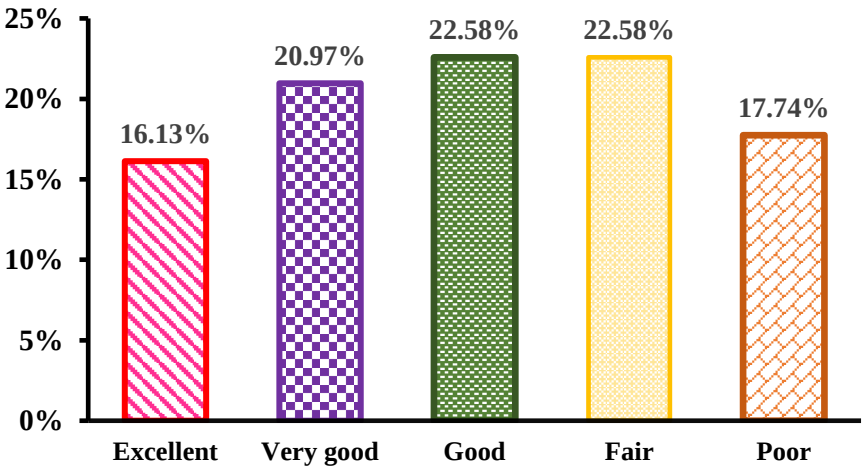

Figure 1: EES Results for Course Outcome 1 (CO1).

Figure 2 shows the frequency score between EES for questions that assess performance on teaching and learning of PO2, which assessed the problem analysis skills in the course learning process. Like the results for PO1, 61 % of the frequency score was also between 2, 3 and 4, indicating that teaching and learning effectiveness for analysing problems in fluid statics, control volumes, model studies and viscous flows in pipes and ducts is in upright condition.

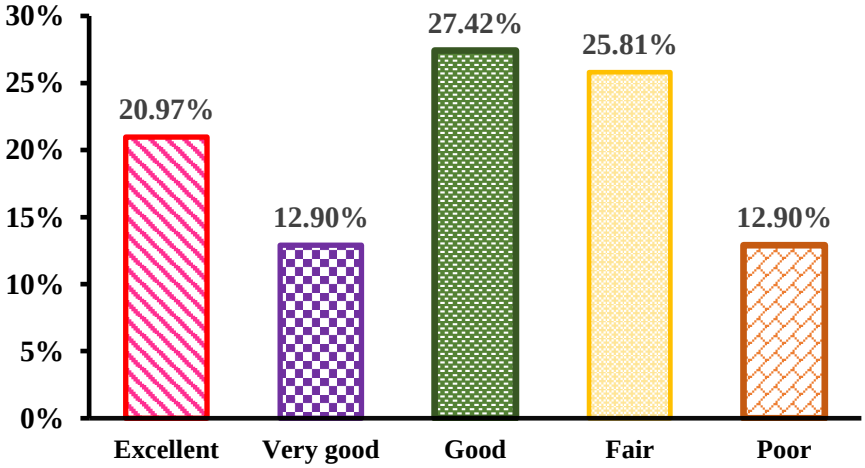

Figure 2: EES Results for Course Outcome 2 (CO2)

Figure 3 represents the EES frequency score for PO3. Based on the results and student's self-rating, 58 % was dominated in the score of 2, 3 and 4, representing 58 % students think teaching and learning in developing solutions for Fluid Mechanics problems related to model studies and viscous flow in pipes and ducts were effective. In addition, approximately 40% of pupils assessed their knowledge and understanding with a frequency score of less than 1. This

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indicates that some of the topics accessed for this PO are extremely complex from the student's point of view.

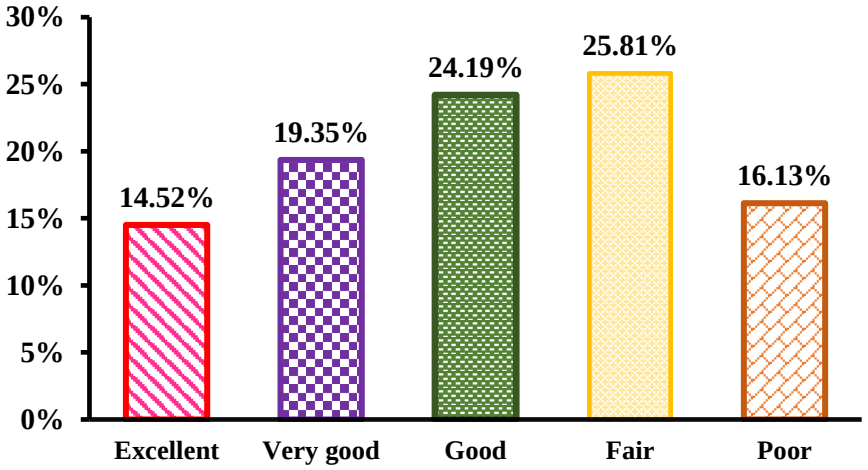

Figure 3: EES Results for Course Outcome 3 (CO3)

Figure 4 shows the percentage of students' achievement for overall course assessment based on CO1:PO1 CO2:PO2 and CO3:PO3. The minimum percentage of each PO attainment to be achieved is set at 65%. The attainment of PO1 is only 30.23% which represent the students perception of their fundamental knowledge based on EES question 1 which approximately 60 % of the students response excellent, very good and good. For PO1, the achievement below 65 % due to the part of the assessment, is the first assessment (Assignment 1) conducted for this course. Furthermore, the teaching, learning, and evaluation for these samples were partly completed online. Although the students' perceptions of their fundamental knowledge were good, their actual performance access for this PO1 did not meet expectations.

PO2 is measured through face-to-face Test and Final Examinations. The performance for PO2, however, has also did not meet the student expectation in the survey where PO2 attainment was 53.49 % achieved above satisfactory level whilst approximately 61% students think there are good, excellent and very good in PO2. To solve this issue, intervention plan should had been executed after Test including monitoring of attendance, extra class and exercises how to answer theoretical and calculation questions. During tutorial class, students were observed as they work and at the same time asking students questions to trigger discussions. Should these measures prove ineffective, the report may also serve as a reference during the five-year curriculum review process.

Finally, for PO3, students achieved the required PO achievement at 98.84%. Through individual assignment, the PO3 was assessed to see whether the students' able to develop solutions for Fluid Mechanics problems related to model studies and viscous flow in pipes and ducts. The effectiveness indicator of teaching and learning based on PO3 is directly linked to the assessment, which affords students sufficient time to engage in problem-solving and grants them access to a diverse range of resources for solution generation.

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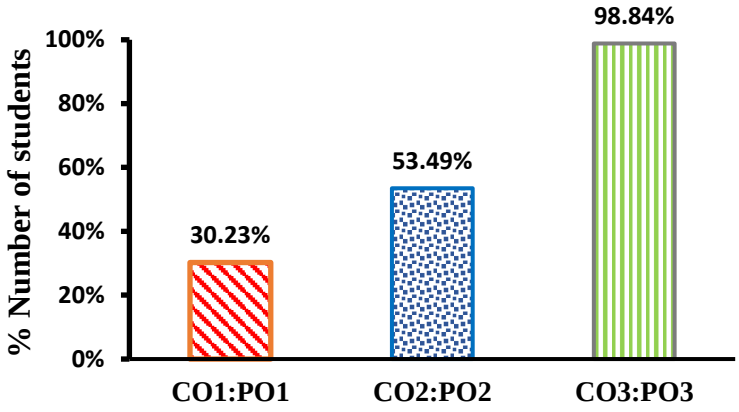

Figure 4: CO-PO Attainment

5. Importance of effective teaching strategies to promote deep learning among students

According to the results derived from the EES survey, the evaluations of both Program Outcomes 1 (PO1) and Program Outcomes 2 (PO2) did not correspond with the perceptions expressed by students regarding their performance as assessed through Assignments, Tests, and Final Examinations. Program Outcome 1 (CO1) demonstrated the most significant deficiencies in performance when assessed against the criteria of excellence and inadequacy. The achievement of the Program Outcome (PO) was conspicuously low, with merely 30.23% of students asserting a perception of their foundational knowledge as indicated by EES question 1, despite nearly 60% of respondents appraising their comprehension as excellent, very good, or good. Although students' perceptions regarding their foundational knowledge seemed to be positive, their actual performance metrics associated with this Program Outcome 1 (PO1) did not meet the expected benchmarks. There are several prospective strategies aimed at enhancing deep learning among students; notably, the incorporation of active learning pedagogies. In particular, for the grasp of fundamental concepts, tutorials on this subject should include collaborative discussions and problem-solving exercises that foster student engagement and teamwork.

Table 3: Reflective Practices to identify strengths and weakness in teaching and learning process

Type of reflection	Methods	Benefits
Self-Reflection	Journals	Improve Teaching
Peer Reflection	Discussion	Professional Growth
Student feedback	Action Research	Enhanced Student Outcomes

The elucidation of fundamental concepts necessitates proficient skills from educators. Moreover, fostering a culture of reflective practices among both students and educators may represent an additional strategy for improvement. Among the method than can be apply by educators are reflective practices (Boulton-Lewis, 2008). Reflective practices entail a systematic examination of one's pedagogical approaches, student engagement, and overall educational experiences. As shown in Table 3, three effective techniques and their corresponding methods and benefits are presented to enable educators to utilize them in their teaching. For instance, self-reflection by maintaining a reflective journal enables educators to chronicle their thoughts, experiences, and insights over time. This process of introspection facilitates educators in discerning effective practices as well as identifying areas necessitating

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enhancement. Whilst through peer reflection, educators may participate in peers discussion groups to facilitate shared learning and collective learning. Additionally, it promotes educators' professional development by cultivating a culture of continuous learning and encouraging adaptable teaching methods. Finally, understanding students' perspectives helps educators tailor their approaches to meet diverse needs and hence an create more supportive and effective learning environments for their students. Through the refinement of their instructional methodologies via reflection, educators can cultivate more supportive and impactful learning environments for their students.

6. Conclusion

This manuscript presents an evaluation of student academic performance based on the attainment of Engineering Educational Standards (EES) and Program Outcomes (PO). The EES questionnaire, utilizing a five-point Likert scale, was meticulously constructed in alignment with the curriculum content of the course, and each pertinent question has been systematically correlated with the corresponding Program Outcomes. The course is associated with three specific Program Outcomes, namely PO1, PO2, and PO3. All data points were subjected to analysis based on the frequency score of EES in conjunction with the related Program Outcomes and Course Outcomes for Program Objectives (COPO) attainment expressed as a percentage. The findings indicate that the assessments of both PO1 and PO2 did not align with the perceptions held by students when their performance was evaluated through Assignments, Tests, and Final Examination assessments. Conversely, an exceptional achievement of over 90% at or above the satisfactory level was recorded for PO3, which surpassed students' self-expectations as indicated by the survey responses. In order to gain a comprehensive understanding, future research efforts should focus on analyzing trends across multiple semesters to assess how EES responses and PO attainment change over time.

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