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FOCUSED EVALUATION STRATEGY FOR UNDERPERFORMING COURSE OUTCOMES: A CASE STUDY IN NUMERICAL METHODS COURSE

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Abstract:

This study investigates the effectiveness of a targeted assessment strategy to improve student performance on an underperforming course outcome (CO) within the Numerical Methods with Applications course (MEC500) which is offered to engineering undergraduates. Course outcome number 1 (CO1) which emphasises conceptual understanding consistently recorded low attainment. In response, a dedicated assessment structure was introduced by segregating CO1 into an individual test, separate from the assessment of CO2 and CO3, which were covered in another test. However, the total test duration and weightage were maintained. Student attainment data over three consecutive semesters were analysed using a quasi-experimental approach, with the third semester representing the implementation of the new assessment strategy. Following the introduction of a dedicated assessment for CO1, the percentage of students meeting the minimum threshold rose significantly to 90.20%, 58% increase compared to the previous semester. Meanwhile the reduction in standard deviation for CO1 suggests that student performance became more consistent after the intervention. Overall, the dedicated assessment structure proved to be both practical and adaptable.



Keywords:

Constructive Alignment, Course Outcome Attainment, Targeted Assessment, Outcome-Based Education (OBE), Engineering Education

Introduction

Course Outcomes (COs) play a critical role in the implementation of Outcome-Based Education (OBE), particularly in engineering bachelor's degree programs. OBE focuses on ensuring that students acquire the intended skills and competencies by the end of their studies. It aligns academic delivery with industry demands and accreditation requirements. In Malaysia, engineering programs offered by institutions of higher learning (IHLs) are routinely reviewed by two main accrediting bodies: the Malaysian Qualifications Agency (MQA) and the Engineering Accreditation Council (EAC). The latter operates under the supervision of the Board of Engineers Malaysia (BEM). Both MQA and EAC adhere to OBE principles as a foundation for maintaining academic quality and producing competent graduates (Malaysian Qualifications Agency, 2017; Engineering Accreditation Council, 2024). According to Premalatha (2019), the COs established for each engineering course are designed to reflect and support the Program Outcomes (POs). They serve as benchmarks for both academic excellence and industry relevance. This alignment is essential in preparing graduates who meet the standards required for professional engineering practice and accreditation.

Numerical Methods with Applications (MEC500) is a course offered to Mechanical Engineering students at Universiti Teknologi MARA (UiTM) Penang Branch. This course assesses three Course Outcomes (COs) through two major tests. Notably, course outcome number 1 (CO1), focusing on conceptual understanding and theoretical comprehension rather than numerical computation has consistently shown lower attainment, likely due to students' preference for calculation-based tasks and their tendency to allocate less attention to CO1 during both study and assessment preparation. This is evident in the March–July 2021 semester, where only 32.14% of students achieved at least 50% in CO1, compared to over 69% and 76% for CO2 and CO3, respectively. Table 1 presents the course outcome statements for MEC500, highlighting that CO4 was not included in the assessments conducted through tests. Students consistently underperform in CO1 due to avoidance in integrated assessments. Since students appear to underperform in CO1 when it is assessed alongside other course outcomes in integrated assessments, it is essential that this issue be systematically examined and addressed through targeted improvements.

Table 1: Course Outcome Statement And Programme Outcome Assessed in MEC500 tests.

Course Outcome	CO Statement	Programme Outcome
CO1	Describe various numerical techniques and their limitations in solving engineering problems	PO1
CO2	Apply various numerical techniques in solving engineering problems	PO1
CO3	Evaluate the numerical techniques in solving engineering problems	PO3

CO4 Construct computational approach to solve engineering PO5
problems (**Not assessed in tests*)

A strategy implemented by Nasser and Mohd (2002) demonstrated that aligning dedicated assessments with specific course outcomes enables educators to provide more targeted and meaningful feedback, thereby helping students better understand their strengths and areas for improvement (Nasser et al., 2002). Such an approach can directly contribute to improving student attainment in underperforming course outcomes. The aim of this paper is to evaluate the effectiveness of segregating CO1 into its own dedicated assessment in Numerical Methods with Applications course (Course code MEC500) for the engineering undergraduate studies in UiTM Penang Branch.

Literature Review

In OBE, clearly defined outcomes guide both teaching strategies and assessment methods, ensuring alignment across all aspects of the educational experience. This alignment enhances the coherence of the curriculum, facilitating better student engagement and achievement. A critical component of OBE is the concept of constructive alignment, which promotes the direct correlation between intended learning outcomes, instructional strategies, learning activities, and assessment methods. Pereira et al. argue that constructive alignment provides clarity and coherence in the learning design. It allows students to comprehend the connection between their learning activities, assessment methods and the overall course objectives (Pereira et al., 2024). Furthermore, the alignment of assessments with specific course learning outcomes allows educators to measure student achievement effectively. As indicated by the implications of the framework introduced by Pereira et al., aligning assessments with clearly defined learning outcomes promotes active learning, engages students, and supports their understanding of the relevance of assessments to their overall educational journey (Pereira et al., 2024). Nasser and Mohd in 2002 also emphasized the importance of aligning assessments with course outcomes. Such alignment ensures that assessments accurately measure the intended learning objectives. It can provide a clear framework for both educators and students in terms of expectations and evaluation criteria (Nasser et al., 2002). Deneen et al. highlight that in teacher education, a well-defined alignment of instructional practices and assessments with OBE principles facilitates active student engagement. It can also enhance academic achievement Deneen et al. [55]. Their study demonstrates that students' evaluations of course constructs, such as interactions and assessments, correlate positively with their overall academic success. This reinforces the idea that assessments should be closely tied to explicit learning outcomes.

One key issue in student engagement is the clarity of learning objectives. Students often struggle to engage meaningfully with course content if they do not understand the specific outcomes they are expected to achieve. Worse they are unable to anticipate the specific outcomes to showcase in their assessments (Griffin et al., 2017). Research suggests that students often prioritize easier questions during tests. This is mainly because of lack of confidence in their ability to answer questions related to certain COs. This strategy allows them to secure points from questions they feel easier. Consequently, it can result in poor performance on COs associated with harder questions. As highlighted by Pape-Zambito and Mostrom, alignment among course learning objectives, teaching, and assessments is critical for ensuring that students engage with all aspects of their learning (Pape-Zambito et al., 2018). This cognitive-prioritizing strategy is also spotted by a study on student's learning approach by

Wang et al. in 2013. This behavior can be attributed to a lack of confidence in their abilities to answer challenging questions effectively. As a result, the students tend to push those items to the end of the test or skip them altogether (Wang et al., 2013). The implication of this behavior is critical, particularly in the context of OBE, where specific COs guide assessment design. If students consistently neglect difficult questions associated with COs, their performance on these outcomes will be badly affected. This tendency may be more prominent during timed-assessment types where students focus on only answering questions they are confident in first. At the end, the students have potential to neglect those aligned with critical outcomes (Irafahmi et al., 2021). This behavior is further amplified when students have previously experienced difficulties with the material, leading to the belief that certain questions will be too challenging. As a result, students may establish a mindset that devalues the importance of striving for mastery in those areas, causing them to engage less effectively with specific Course Outcomes (Wittstrom et al., 2010). In the context of this study, students may have encountered difficulties with CO1-related questions during the first test. As a result, they were less likely to prioritize CO1-related content in their preparation for the second test, potentially contributing to continued underperformance in this outcome. This claim is true as presented by Wittstrom et al. in their 2010 study (Wittstrom et al., 2010).

Wang et al. highlight that the alignment of teaching methods and assessments tends to shape students' learning approaches, suggesting that constructive alignment could lead students to adopt more deep learning strategies rather than surface ones (Wang et al., 2013). In 2014, Zelenitsky et al. examined the impact of curriculum mapping to effectively align assessments with core competencies (similar to programme outcome) in undergraduate pharmacy programs. Their study demonstrated that systematic mapping and alignment with learning outcomes not only enhanced the clarity of educational objectives but also improved student satisfaction and academic performance. Students gained a better understanding of the connection between course content, competencies, and assessments, reinforcing the benefits of alignment (Zelenitsky et al., 2014). In 2015, Boud et al. studied how aligning assessments with course objectives can lead to sustainability in student performance showing that constructive alignment increases student engagement and mastery of competencies, leading to better long-term outcomes (Boud et al., 2015). In 2013, Cain studied implemented portfolio assessment in an introductory programming unit, which led to improved pass rates and demonstrated student's ability to apply learned concepts and conduct small research projects (Cain, 2013). Meanwhile there is a study concluded that the idea of individual assessments aligned with course outcomes can lead to better student performance. This conclusion was drawn from a study on teaching academic paragraph writing in a virtual flipped classroom according to constructive alignment principles (Lameshkani et al., 2024). From all these reviews, it is evident that aligning an assessment to a single course outcome can benefit students in many ways, particularly by improving their performance on that specific outcome. Sweller in 1994 has earlier hypothesised that the improved students' performance while applying assessment alignment was directly caused by managing well the students' cognitive load. Cognitive load theory, as proposed by Sweller, suggests that learners have a limited capacity in working memory, which can be overwhelmed by tasks that demand simultaneous processing of unrelated information (Sweller, 1994). In addition, recent studies have shown that ambiguous or overly integrated assessments may increase student anxiety, particularly among those who struggle with theoretical or non-numerical content, due to heightened cognitive load and reduced confidence [(Putwain et al., 2014; Papadakis, 2023). Test anxiety as they called, has

been identified to reduce students' performance, particularly in STEM fields where conceptual mastery is critical (von der Embse et al., 2018).

Methodology

Prior to the implementation of aligning an assessment to a single course outcome, the course assessment strategy involved evaluating several course outcomes (COs) collectively through common instruments such as quizzes, tests, and the final examination. Data from two semesters, namely the October 2020 – February 2021 semester and the March – July 2021 semester, highlighted a persistent issue in student performance for CO1. In the first semester, 88.57% of students achieved the minimum threshold for CO1, while only 80% achieved it for CO2. However, in the following semester, the attainment rate for CO1 dropped significantly to 32.14%, while CO2 decreased to 69.64%. This sharp decline, particularly in CO1, underscored a potential misalignment between assessment design and outcome expectations, further justifying the need for an improved, outcome-targeted assessment strategy. This underperforming CO1 was only assessed in tests, namely Test 1 and Test 2. Both tests assessed CO1, CO2, and CO3, with each carrying a total of 30 marks as shown in Table 2.

Table 2: Course Outcomes Assessed In Two Tests.

Course outcomes	Marks out of 30	
	Test 1	Test 2
CO1	6	9
CO2	18	12
CO3	6	9

Intervention Strategy

The intervention strategy was to assess CO1 through a dedicated assessment by dividing each test into two parts, where Part A contained assessment items for CO1 only, and Part B contained items for CO2 and CO3. This strategy was an adaptation from works by Wang et al. in 2013 and Boud in 2015 (Wang et al., 2013 and Boud et al., 2015). The proposed division for both tests is shown in Table 3. The weightage of the COs in the tests remained unchanged, as did the total marks allocated for each test. Although the number of test components was doubled, the total duration for each test remained the same. This new division of assessment was communicated to the students in the October 2021 – February 2022 semester during the introductory lecture in Week 1 and was further reinforced through reminders as the test dates approached.

Table 3: Division of test into Part A and Part B to separate CO1 assessment.

Course outcomes	Marks out of 30			
	Test 1 (Part A)	Test 1 (Part B)	Test 2 (Part A)	Test 2 (Part B)
CO1	6		9	
CO2		18		12
CO3		6		9

Study Design

This study employed a quasi-experimental design to evaluate the effectiveness of aligning assessments to individual course outcomes (COs) in improving student performance in CO1 especially. The intervention was implemented in the October 2021 – February 2022 semester,

while data from the two preceding semesters (October 2020 – February 2021 and March – July 2021) served as the baseline for comparison. The intervention involved restructuring test formats to isolate CO1 into a dedicated test section, while maintaining the same test duration and weightage across COs.

Student performance data were collected based on CO attainment percentages calculated from mapped assessment items. The results were analysed by comparing the percentage of students achieving the 50% attainment threshold for CO1, CO2 and CO3 before and after the intervention. Descriptive statistics were used to summarise attainment trends, while comparative analysis using attainment percentages was used to evaluate performance shifts across the three semesters. This approach enabled the study to assess whether the modified assessment design contributed to improved clarity, focus, and performance related to specific learning outcomes.

Results and Discussions

The minimum attainment threshold for both programme outcomes and course outcomes were 50%. Figure 1 presents the percentage of students who achieved the minimum CO attainment ($\geq 50\%$), with the October 2021 – February 2022 semester marking the implementation of individual test sections for CO1.

Table 4 presents the mean attainment and standard deviation of CO1 for the pre- and post-intervention semesters. The results show that the implementation of a dedicated CO1 assessment increased the mean attainment of students in the MEC500 course by 22.6%. Although the post-intervention mean was slightly lower than that recorded in the October 2020 – February 2021 semester, the standard deviation improved significantly. Meanwhile, Figure 2 presents the mean and standard deviation (error bar) for all COs included in the study, where the attainment for CO2 and CO3 was evaluated based solely on test results. With the implementation of the dedicated CO1 assessment, separated from the CO2 and CO3 questions, the mean attainment percentages for all COs increased, with each exceeding the 50% threshold.

Referring to results on figure 1, the CO1 attainment for the March – July 2021 semester was particularly poor, with only 32.14% of students in the MEC500 course achieving the minimum threshold of 50%. CO2 and CO3 attainment in the same semester were also unsatisfactory, with fewer than 80% of students meeting the 50% attainment benchmark. The implementation of individual assessments for CO1 resulted in a significant improvement in CO attainment, particularly for CO1, which increased by 58%, with over 90% of students achieving at least 50%. The other two COs also showed notable improvements, with increases of 20.6% for CO2 and 13.4% for CO3, respectively.

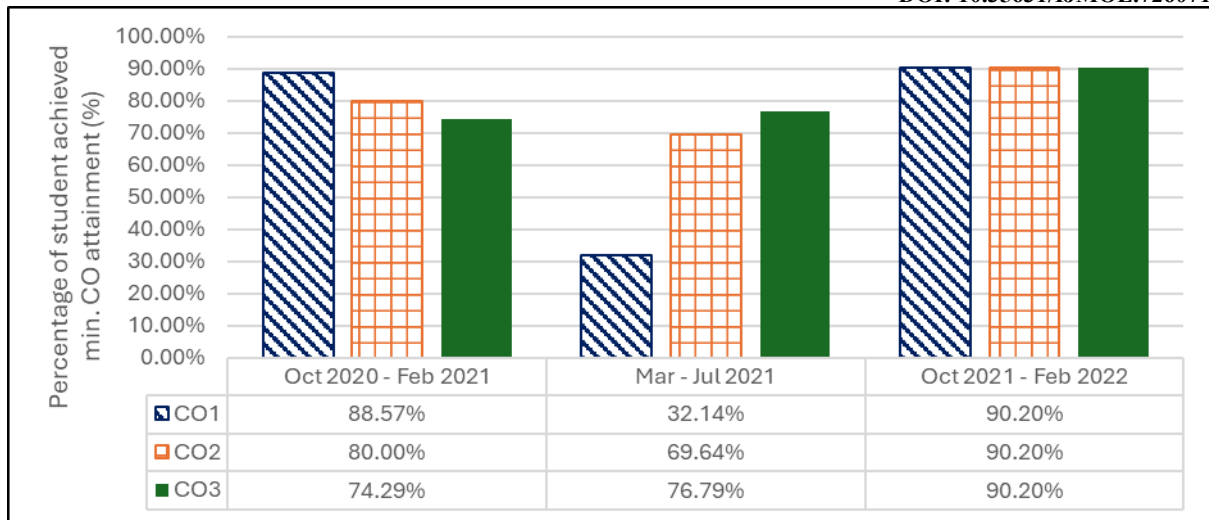


Figure 1: Students Achieving Minimum CO Attainment of 50%.

Table 4: Mean and Standard Deviation of CO1 Attainment

	Semester		
	Oct 2020 - Feb 2021	Mar - Jul 2021	Oct 2021 - Feb 2022
Mean attainment (%)	78.69	43.9	66.55
Standard deviation	17.61	19.08	12.32

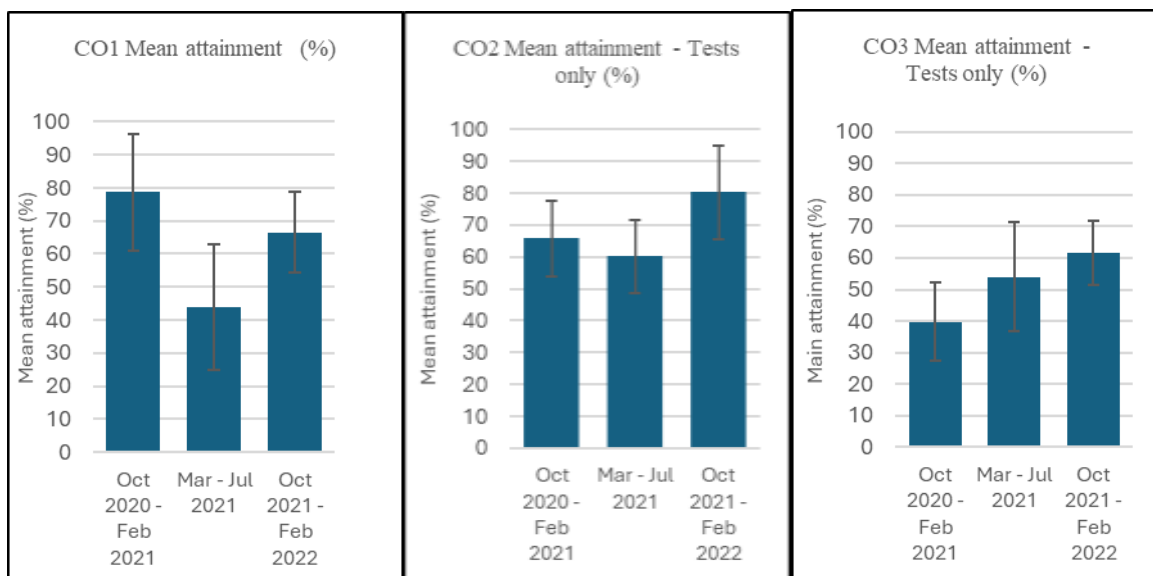


Figure 2: Mean Value of CO1, CO2 and CO3 Attainment Across Semesters.

Impact Of Assessment Clarity On Cognitive Load And Student Anxiety

Overall, the attainment for all COs in the semester that implemented the dedicated assessment for CO1 improved significantly, with each CO recording over 90% of students achieving above the 50% threshold. This finding supports the principle of constructive alignment, as outlined by Biggs (1996, 2011), in which learning outcomes, teaching activities, and assessments are

explicitly aligned to reinforce student learning. In this study, by aligning a test assessing only CO1, students were given clearer expectations and more focused preparation, resulting in a significant marked increase in CO1 attainment. This outcome is consistent with Biggs's view that "constructive" refers to students actively constructing meaning through relevant learning activities, and "alignment" means that these activities and assessments are purposefully designed to support the intended outcomes. When CO1 was previously assessed together with CO2 and CO3 in the same test, the learning intent was diffused, and student preparation may have lacked direction. The data show that such unfocused assessment likely contributed to underperformance in CO1, despite its conceptual weight in the course. Besides, when CO1, which emphasizes theoretical comprehension, students may have experienced cognitive overload, leading to diminished performance. By separating CO1 into its own assessment, students were able to focus solely on conceptual reasoning. Consequently, it reduced irrelevant cognitive load which caused anxiety and enhanced learning outcomes as suggested by Sweller in 1994 (Sweller, 1994). The implementation of a clearly segmented test likely provided psychological relief as discussed by Putwain et al. in 2014 and von der Embse et al. in 2018. It allowed students to engage more confidently with CO1 material.

Impact On Lower Performing Students

The improvement in standard deviation after intervention indicates not only better average attainment but also greater consistency among students in mastering CO1-related content as the numbers shown in Table 4. This suggests that lower-performing students particularly benefited from the dedicated CO1 assessment. By isolating CO1-related questions in a clear section, students with weaker performance in multi-outcome settings may have been better able to concentrate their preparation, understand expectations, and apply knowledge more effectively. The improvement in CO2 and CO3—by 20.6% and 13.4%, respectively—even though they were not directly modified, indicates that clarity in one part of the assessment can positively influence overall preparation and student engagement. This indirect benefit highlights the broader value of clear alignment not only for performance but also for improving the quality of learning experiences.

Student Motivation And Perception Toward Theoretical Questions

The implementation of an isolated CO1 assessment may have also influenced student motivation and perception toward conceptual questions. According to expectancy-value theory by Wigfield et al. in 2000, students are more likely to exert effort on tasks they perceive as important and achievable (Wigfield et al., 2000). Prior implementation of isolated CO1 assessment, student not prioritizing or even avoiding CO1 conceptual questions was not random accusation but fully supported by previous studies by Pape-Zambito et al. in 2018, Wang et al. in 2013 and Irafahmi et al. in 2021. Thus, CO1 questions have been overshadowed by more computation-heavy questions, leading students to devalue or deprioritize it. The dedicated assessment implicitly signalled the importance of CO1, potentially elevating its perceived task value. Moreover, the increased clarity of expectations may have fostered a sense of competence and autonomy. These two elements are essential components of intrinsic motivation as articulated by self-determination theory (Ryan et al., 2000). This motivational shift may explain the improved engagement and attainment observed in the post-intervention semester.

Adaptability And Practicality Of The Assessment Alignment

All the performance improvement discussed above were achieved without increasing total test time or changing the overall weightage of the course assessments. This reinforces the practicality of the intervention which offers a viable strategy for curriculum improvement that does not demand additional resources or student workload, yet yields measurable improvements in learning outcomes. Such an approach could be readily adapted for other technical or outcome-driven courses where specific outcomes repeatedly underperform. This kind of approach suits well with national (Malaysia) and international standards for quality assurance in higher education. Both the Malaysian Qualifications Agency (MQA) and the Engineering Accreditation Council (EAC) emphasize outcome-based approaches in their programme evaluation frameworks (Malaysian Qualifications Agency, 2017; Engineering Accreditation Council, 2024). The dedicated assessment for CO1 exemplifies a constructive alignment strategy. It demonstrated the best practices in curriculum mapping and quality assurance.

This approach also aligns with continuous quality improvement (CQI) principles that are central to engineering education. According to Bourne et al. (2016), interventions that yield measurable gains in CO attainment, while maintaining resource efficiency should be viewed as high-impact practices for curriculum refinement. Thus, the assessment strategy presented in this study offers a replicable model for courses seeking to improve specific outcomes.

The findings from this study suggest high potential for adaptability, especially to other technically oriented courses where underperforming conceptual outcomes are common. Courses in thermodynamics, fluid mechanics, or materials science often characterized by a mix of theory and application. These courses could benefit from dedicated assessments targeting specific learning domains. Moreover, the intervention could be tested in non-engineering disciplines such as economics or psychology, as well. If similar gains in outcome-specific attainment are observed, it would support the argument that the benefits of constructive alignment transcend disciplinary boundaries. Such evidence could also encourage policy-level adoption of assessment reforms in broader curriculum guidelines.

Comparative Perspective: Advantages Over Other Pedagogical Interventions

While various strategies such as flipped classrooms, rubric-based evaluations, and problem-based learning (PBL) have demonstrated success in improving student learning, this study provides evidence that even minor structural changes in assessment design can yield significant performance gains. Unlike pedagogical reforms that often require substantial changes in teaching style or additional contact hours, this assessment-specific intervention is minimal in operational cost. For instance, Freeman et al. in 2014 reported significant learning gains from active learning interventions in STEM, yet such strategies often demand extensive instructor training and student adaptation (Freeman et al., 2014). Meanwhile, a clearly segmented test layout like in this study can be implemented immediately without disrupting existing teaching schedules. This positions the intervention as a pragmatic alternative or complement to broader teaching innovations.

Conclusions

This study set out to assess whether separating Course Outcome 1 (CO1) into its own dedicated assessment could improve student performance in the Numerical Methods with Applications course (MEC500) at UiTM Penang Branch. The intervention involved redesigning the test

format so that CO1 was assessed independently from the other course outcomes, with the goal of making the assessment more focused and better aligned with the intended learning objectives. The results showed a clear improvement in student performance, especially for CO1, which had been underperforming in earlier semesters. Following the change, more than 90% of students met the minimum 50% threshold for CO1 which is a 58% increase from the previous semester. Interestingly, CO2 and CO3 also saw performance gains, even though they were not the focus of the intervention.

The findings indicate that constructive alignment, particularly through assigning a dedicated assessment to a single course outcome can be a practical and effective approach for improving student learning and performance. When assessments are clearly tied to specific outcomes, students benefit from a clearer sense of direction and are better equipped to focus their preparation. The noticeable drop in standard deviation for CO1 attainment also points to more consistent performance across the student group, suggesting that the revised assessment format may have been especially beneficial for students who previously struggled. By making expectations more transparent and structuring the assessment around a single outcome, the approach appears to have made it easier for these students to engage with and understand the material.

Importantly, the improvements observed in student performance were achieved without extending the total test duration or altering the overall assessment weightage. This highlights the practicality of the intervention, making it an adaptable option for enhancing curriculum delivery. The success of this outcome-specific strategy also suggests it could be applied to other technically focused courses with underperforming outcomes. Overall, the study underscores the value of constructive alignment and targeted assessment design as effective means of boosting both student achievement and instructional effectiveness in higher education.

While the findings of this study are encouraging, several limitations should be considered. First, the use of a quasi-experimental design without randomised group assignment limits the strength of causal claims. The student cohorts being compared came from different semesters. They may have differences in their academic readiness, motivation levels, or prior exposure to course content which may have influenced the results. Second, the study was confined to a single course (MEC500) at one institution. It may affect how broadly the findings can be applied to other courses and programmes. Additionally, the analysis focused exclusively on attainment data and did not include qualitative input from students or instructors. It could have provided richer insight into the learning experience. Future research might consider adopting mixed-method approaches, examining long-term knowledge retention, or implementing similar assessment strategies in other courses with underperforming outcomes to further explore the effectiveness and scalability of this intervention.

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