

Continuous Quality Improvement for Civil Engineering Course During and After the Covid-19 Pandemic

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ABSTRACT

The Covid-19 outbreak has profoundly affected teaching and learning, necessitating a careful transition back to conventional methods in the post-pandemic era. This study examines the Continuous Quality Improvement (CQI) of Course X in Civil Engineering during and after Covid-19, focusing on specific challenges faced and measures implemented during this transition. The evaluation includes an assessment of academic performance through diagnostic tests, course outcomes, program outcomes, and student feedback as components for planning effective CQI initiatives. Overall CO-PO performance metrics indicate that in semester 20214, CO1-PO1 was attained at 86%, while CO2-PO2 achieved 71%. However, during face-to-face assessments in semesters 20224 and 20234, a significant decline was observed: CO1-PO1 dropped to 54% and 53%, respectively, while CO2-PO2 decreased to 61% in semester 20224 and slightly increased to 62% in semester 20234. These findings underscore that while students adapted well to online learning, they faced significant barriers when transitioning back to hands-on activities. This research provides targeted insights into enhancing educational delivery methods post-pandemic, highlighting the necessity of integrating traditional and innovative teaching strategies to foster student engagement and improve learning outcomes. The implications are particularly relevant for educators and policymakers as they refine curricula and teaching methodologies to address the evolving needs of students in response to global disruptions.

Keywords: Continuous quality improvement; Covid-19; civil engineering education; program outcomes; academic performance

INTRODUCTION

The Covid-19 pandemic was declared a global health emergency, leading to significant disruptions across various sectors (Zainal et al. 2023), including education. On March 11, 2020, the World Health Organization (WHO) officially recognized Covid-19 as a global pandemic. In response, the Malaysian Ministry of Higher Education mandated that all university and college teaching and learning activities shift from face-to-face to online format until the end of 2020. This swift transition resulted in the widespread implementation of Open and Distance Learning (ODL) systems to ensure educational continuity.

The pandemic has fundamentally reshaped the landscape of education, particularly in teaching and learning (T&L), posing significant challenges to students, educators, and institutions worldwide. Prior to the pandemic, traditional teaching methods relied heavily on face-to-face interactions in physical classrooms, where educators delivered instruction through lectures, discussions, and hands-on activities, fostering direct engagement and collaboration among students (Razali & Nasri 2023). However, the rapid onset of the pandemic necessitated a sudden shift to online and remote instruction, which challenged educators to adapt their pedagogical approaches. This transition also highlighted inequities in access to technology and educational resources,

complicating the educational experience during this unprecedented crisis (UNESCO 2020).

This disruption not only required a quick shift to online education but also exposed significant gaps in technological access. Students from disadvantaged backgrounds faced heightened difficulties due to inadequate digital infrastructure, exacerbating pre-existing inequalities in education. Research indicates that this transition has adversely impacted student achievement, with studies showing significant decline in learning outcomes, particularly among those from low-income families (Kuhfeld & Tarasawa 2020). Furthermore, the long-term consequences of these disruptions are still emerging, raising concerns about student engagement and the overall quality of education as institutions adapt to new teaching modalities. Thus, the pandemic has not only reshaped T&L environment but also posed significant challenges to students, educators, and institutions worldwide.

Before the pandemic, traditional teaching methods relied heavily on face-to-face interactions in physical classrooms. However, the rapid onset of the pandemic required an immediate transition to online instruction, which challenged educators to adapt their pedagogical strategies while exposing inequities in technological access among students.

Engineering programs were particularly affected by this shift due to their reliance on practical, laboratory-based activities that are integral to the learning experience. This reliance raised serious concerns about how these changes impacted educational outcomes especially Program Outcomes (POs), which define the knowledge, skills, and attitudes that students are expected to acquire by graduation.

Despite existing literature on online education, there remains a notable gap regarding the effectiveness of various teaching methods in engineering disciplines of post-pandemic. Many studies have explored online learning's impact; however, few have examined how these experiences translate back to conventional teaching methods and their implications for student performance in civil engineering. This research aims to fill that gap by analyzing CO-PO attainment rates and student feedback across different semesters, providing insights into how educational delivery can be enhanced in moving forward.

COURSE OUTCOMES (COS) AND PROGRAM OUTCOMES (POS)

Teaching and learning encompass three interconnected domains: cognitive (knowledge acquisition), psychomotor (skills development), and affective (emotions and

attitudes). Effective integration of these domains is essential for optimal educational outcomes. The Covid-19 pandemic disrupted these domains, with significant implications for Program Outcomes (POs) in many accredited programs, particularly civil engineering. POs refer to the specific abilities students should demonstrate upon completing a program, as outlined by accreditation standards such as the Engineering Technology Accreditation Council (ETAC 2020).

Yong et al. (2022) explored the pandemic's impact on engineering programs and found that student satisfaction with their degree programs dropped significantly. This decrease in satisfaction, measured through surveys assessing accessibility, quality of interaction, and the effectiveness of online learning, led to a corresponding decline in the performance of POs. Such findings highlight the need for a robust Continuous Quality Improvement (CQI) process to ensure that educational standards are maintained even in challenging environment.

While POs provide a broad framework for evaluating program effectiveness, Course Outcomes (COs) offer more granular insights into student learning. COs are specific to individual courses and outline the knowledge and skills students should acquire in each one. By evaluating COs, educators can assess how well individual courses contribute to achieving overall program goals.

The need for detailed CO assessment has been emphasized in various studies. For instance, Biggs and CIPHER (2024) examined COs in nursing programs, identifying areas where certain student groups struggled. Their findings can be applied to other disciplines, including engineering, to improve the alignment between course content and POs. The process of assessing COs allows educators to refine course design, teaching methods, and assessment strategies, ensuring that each course contributes effectively to the program's broader goals.

CONTINUOUS QUALITY IMPROVEMENT (CQI) IN EDUCATION

In addition to assessing Program Outcomes (POs) and Course Outcomes (COs), diagnostic testing and student feedback play critical roles in Continuous Quality Improvement (CQI). Diagnostic tests, administered at the beginning of courses, help educators identify students' strengths and weaknesses, allowing them to tailor instruction to meet individual learning needs. This approach is essential in times of crisis, such as during the pandemic, when learning environment changes rapidly and students may struggle to adapt. For example, Bonari et al. (2023) used diagnostic testing in mental health research to

classify students' psychological well-being, demonstrating how diagnostic tools can provide critical insights into student needs. Similarly, diagnostic tests in educational settings can help identify learning gaps early on, enabling educators to adjust their teaching methods accordingly.

Student feedback mechanisms, such as questionnaire surveys targeting specific groups of students who have taken the course, are crucial for understanding the effectiveness of teaching and learning strategies. By collecting feedback about their experiences, educators can identify areas for improvement and make data-driven decisions. This feedback loop is a vital component of CQI, as it helps ensure that educational programs remain responsive to student needs.

Accreditation bodies like ETAC emphasize the importance of CQI, which involves ongoing efforts to improve educational practices through systematic evaluation. CQI promotes accountability by measuring student performance against established benchmarks and outcomes. Teamwork is assessed through collaborative projects and group assignments that require students to work together effectively. Employee engagement is gauged by faculty involvement in the CQI process, including participation in professional development activities and contributions to curriculum design. CQI is often measured through indicators such as student engagement, teamwork, and feedback mechanisms (ETAC 2020). It helps institutions adapt to changes in student needs and external factors, such as the sudden shift to online education caused by the pandemic.

Earlier studies on CQI in education, such as those by Kahn et al. (2020), analysed students' perceptions of POs in engineering programs. Their research indicated that students have positive perceptions regarding their achievement of essential POs, including engineering knowledge, problem-solving skills, and teamwork competencies. Specifically, the study highlighted that students feel well-prepared in technical areas but identified gaps in soft skills and communication abilities. However, the gap in the literature between their study and more recent ones, such as those by Chicca and Shellenbarger (2024) and Thompson et al. (2024), underscores the need for updated analyses that account for the drastic changes in education delivery due to global disruptions like the Covid-19 pandemic. These changes have likely impacted students' experiences and perceptions of POs, necessitating further investigation into how educational outcomes have evolved.

METHODOLOGY

The Covid-19 pandemic has forced educational institutions to adapt their teaching methods to ensure learning continuity while adhering to health and safety protocols. This transition necessitated shifting from traditional teaching methods to online and distance learning platforms. Consequently, teaching and learning (T&L) strategies and program outcomes (POs) had to be re-evaluated to align with Outcome-Based Education (OBE) principles. OBE focuses on achieving specific learning outcomes and ensuring alignment with industry requirements and professional standards set by accreditation bodies like ETAC.

The implementation of OBE principles has fostered a culture of continuous quality improvement within the Civil Engineering program. Educators can refine their teaching approaches by clearly defining learning outcomes and assessment criteria, ensuring students acquire the necessary skills and knowledge to excel. These principles also provide a framework for assessing student performance and program effectiveness, enabling educators to identify areas for improvement.

Open Distance Learning (ODL) became a flexible learning approach during the pandemic, enabling students to access course content anytime and anywhere. Raihana et al. (2021) emphasized that ODL offers students flexibility regarding learning speed, location, methods, and assessment formats. Recorded lectures and various online resources also contribute to this adaptability. As institutions transitioned back to face-to-face teaching after Covid-19, this study offers a unique opportunity to compare the effectiveness of different teaching methods (ODL, traditional, and hybrid) on student performance.

This study used a rigorous research methodology to ensure data validity and reliability. Quantitative data analysis through descriptive statistics was utilized to assess student performance across different semesters, including diagnostic tests, quizzes, assignments, and final exams. Qualitative data were gathered from student feedback via questionnaire in the SUFO system, allowing for insights into students' perceptions and experiences.

In this study, one of the courses in the Civil Engineering diploma program, namely Course X, was selected for second-year students (semester 3) 20214 (October 2021 – February 2022), 20224 (October 2022 – February 2023), and 20234 (October 2023 – February 2024). The implementation of T&L for each semester is presented in Table 1. The implementation of T&L during and after Covid-19 is different, as ODL was used during Covid-19 and traditional face-to-face method was reinstated afterwards. The research methodology flowchart for its

implementation is shown in Figure 1. It is assumed that students in each semester have similar educational background since they entered the Civil Engineering program based on their Sijil Pelajaran Malaysia (SPM) result, which is a standardized examination taken at the end of secondary school in Malaysia. The SPM result is used as a screening tool for university admissions, ensuring that students meet the necessary academic criteria for entry into higher education programs.

To assess the effectiveness of these T&L strategies, a diagnostic test was conducted at the beginning of the course to evaluate students' prior knowledge relevant to the subject matter. The results were analysed based on assessments for each semester and student feedback. Key assessments included assignments designed to test the understanding of course material, short quizzes that evaluate knowledge of specific topics, and a comprehensive final exam that assesses overall learning throughout the semester.

Student feedback was collected using Student Feedback Online (SUFO) analysis. The tools are typically utilized to gather insights into students' learning experiences. The SUFO system provides structured feedback on various aspects of the course, including teaching effectiveness, course content, lecturer professionalism, and the adequacy of T&L infrastructure.

This structured approach allows us to gather valuable insights into students' learning experiences across different semesters, providing a basis for curriculum improvements. By concentrating on SUFO analysis, we aim to present a comprehensive view of student perceptions that could inform future instructional strategies and enhance educational outcomes. The findings from both diagnostic tests and overall student assessments for each semester are compared using histogram charts that facilitate a thorough evaluation of the effectiveness of the implemented T&L strategies during and after Covid-19.

TABLE 1. The implementation of the T&L for the respective semester

	Semester	Method of implementation	During/ after Covid-19
20214	Oct. 2021 – Feb. 2022	Open distance learning (ODL)	During Covid-19
20224	Oct. 2022 – Feb. 2023	Face to face	After Covid-19
20234	Oct. 2023 – Feb. 2024	Face to face	After Covid-19

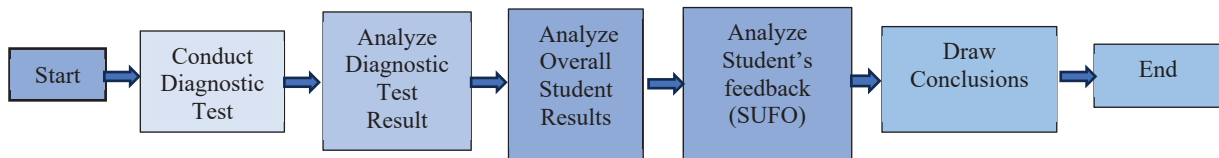


FIGURE 1. Research Methodology Flowchart for Course X Implementation

Tables 2 and 3 outline the course assessments across the different semesters, focusing on the alignment of COs and POs. During the pandemic (20214), assessments

included quizzes, assignments, and two tests. Post-pandemic semesters (20224, 20234) followed a more traditional approach: a test, an assignment, and a final exam.

TABLE 2. Assessment measures by semester 20214 based on CO-PO alignment

Assessment	Topics	Marks		
		CO1PO1	CO2PO2	
Quiz	3	5%	5%	Carry marks (40%)
Assignment	1	5%	25%	
Test 1	1,2	6%	12%	Replace final exam (60%)
Test 2	2,3,4	9%	33%	

TABLE 3. Assessment measures by semester 20224 & 20234 based on CO-PO alignment

Assessment	Topics	Marks		
		CO1-PO1	CO2-PO2	
Test 1	1,2	5%	25%	Carry marks (40%)
Assignment	3	5%	5%	
Final exam	1,2,3,4	15%	45%	Final exam (60%)

The quiz contributes 5% of CO1 and 5% of CO2, while Assignment 1 allocates 5% of CO1 and a significant 25% of CO2. Test 1 replaces the final exam, contributing 6% of CO1 and 12% of CO2, while Test 2 accounts for 9% of CO1 and a substantial 33% of CO2.

In contrast, the post-pandemic semesters (20224 and 20234) adopted a more traditional assessment approach. These semesters include a test, an assignment, and a final exam. In these assessments, Test 1 contributes 5% of CO1 and a more substantial 25% of CO2. Assignment 3 maintains a consistent contribution of 5% to both COs. The final exam, covering all topics related to COs, allocates a significant 15% of CO1 and 45% of CO2. This shift in assessment strategy reflects an effort to realign educational practices with traditional methodologies while still ensuring that course outcomes effectively map onto the program outcomes.

DIAGNOSTIC TESTS

Diagnostic tests play a crucial role in enhancing teaching and learning (T&L) for several reasons. Firstly, they provide lecturers with valuable insights into students' existing knowledge, skills, and competencies at the beginning of a course or program. By assessing students' foundational knowledge, lecturers can identify individual strengths and weaknesses, allowing them to tailor instruction to meet the diverse needs of learners. This targeted approach ensures that instruction is relevant and effective. Additionally, diagnostic tests help lecturers identify gaps in prerequisite knowledge or misconceptions that may hinder students' learning progress. By addressing these issues early on, educators can implement targeted interventions that support student growth. Furthermore, diagnostic tests serve as benchmarks for measuring student progress over time, facilitating ongoing assessment and adjustment of instructional strategies to effectively support student learning. Research supports the significance of diagnostic testing in education. For example, Hernandez Cardenas et al. (2021) found that diagnostic assessments significantly enhance student engagement by providing

personalized feedback that informs instructional practices. Similarly, Mavridis and Koutouzis (2020) emphasized that effective assessment strategies are essential for promoting student engagement and improving academic outcomes. In this study, the diagnostic test was administered during the first week of the semester, focusing on basic subject knowledge to ensure that the students were adequately prepared before attending Course X. The results of these diagnostic assessments were then analysed and compared with the subsequent results from Course X, providing a clear picture of how initial knowledge levels influence overall performance.

By integrating diagnostic testing into the curriculum, educators can enhance T&L by promoting personalized learning experiences that maximize student achievement. This proactive approach not only fosters a deeper understanding of course material but also cultivates an environment where students feel supported in their educational journey. Ultimately, the implementation of diagnostic tests contributes significantly to improving educational outcomes, particularly in a dynamic learning environment shaped by the challenges posed during and after the Covid-19 pandemic.

COURSE OUTCOMES (COS) AND PROGRAMME OUTCOMES (POS)

The Program Outcomes (POs) defined by ETAC reflect the core knowledge, skills, and competencies expected from graduates of the Civil Engineering diploma program. These outcomes, detailed in Table 4, encompass essential areas such as technical knowledge, problem-solving abilities, communication skills, teamwork, and ethical responsibilities. The alignment of Course Outcomes (COs) with POs ensures that Course X contributes meaningfully to the overall program objectives. Table 4 outlines the specific COs and their corresponding POs, illustrating how Course X is designed to equip students with the necessary competencies. For instance, CO1 focuses on applying physical and engineering properties knowledge, while PO1 emphasizes the application of engineering fundamentals

and practical procedures. Similarly, CO2 pertains to evaluating soil behaviour, aligning with PO2's focus on problem analysis within the field. This alignment is crucial to ensure that students not only acquire theoretical knowledge but also develop practical skills relevant to their future careers in civil engineering. Table 5 presents the Key Performance Indicators (KPIs) for evaluating PO achievement. The performance indicators categorize

student performance into three levels: Excellent (70-100%), Good (50-69%), and Fail (0-49%). This structured evaluation framework allows educators to assess how well students meet the established POs. The total achieved POs indicate that a significant number of students have successfully met or exceeded the expected standards, reflecting the effectiveness of the course in maintaining educational quality.

TABLE 4. The COs and POs for the Course X in civil engineering programme

COs	CO statement	POs	PO statement
CO1	Apply physical and engineering properties knowledge to the wide application of soil mechanics	PO1	Engineering knowledge: Apply knowledge of applied mathematics, applied science, engineering fundamentals and an engineering specialization to widen practical procedures and practices.
CO2	Evaluate soil behaviour including flow of water through soil, shear strength, compaction and consolidation from the standpoint of effective stress concept	PO2	Problem analysis: Identify and analyse well-defined engineering problems reaching substantiated conclusions using codified methods of analysis specific to their field of activity.

TABLE 5. Performance indicator for POs

Performance key performance indicator – PO Based					
PO Score %	KPI Category	No. of POs.	Indicator	Total	
70 - 100	Excellent	4	PASS	4	
50 - 69	Good	1		1	
0 - 49	Fail	0	FAIL	0	
Total achieved PO (PASS)				5	

The detailed analysis of CO-PO alignment demonstrates how each assessment in Course X contributes to meeting the POs during and after the pandemic. During the pandemic, teaching methods shifted to Open Distance Learning (ODL), which requires a review of assessment strategies to ensure they remain effective in measuring student competencies. Despite these challenges, the course maintained its standards of educational quality by adapting assessments to align with OBE principles.

As institutions transitioned back to face-to-face instruction post-pandemic, this study provides valuable insights into how different teaching methodologies impact student learning outcomes. By continuously assessing CO-PO alignment and utilizing structured feedback mechanisms like SUFO, educators can identify areas for improvement and adapt their teaching strategies accordingly. This commitment to quality improvement ensures that graduates are well-prepared to meet industry demands and excel in their professional careers.

STUDENT'S FEEDBACK

The Student Feedback Online (SUFO) system was developed by Universiti Teknologi MARA to systematically gather structured feedback from students regarding their educational experiences. This tool evaluates various aspects of the course, including teaching effectiveness, course content, lecturer professionalism, and the adequacy of teaching and learning (T&L) infrastructure. The four key sections evaluated in the SUFO (A, B, C, D) are presented in Table 6. This structured approach allows for comprehensive insights into students' learning experiences across different semesters. By focusing on these key areas, the SUFO system helps identify strengths and areas for improvement within the course framework. The feedback collected through SUFO is instrumental in informing curriculum enhancements and refining instructional strategies. The development of SUFO involves the

collaboration of educators and administrators to ensure that it effectively captures student perceptions. This feedback mechanism aligns with the principles of Outcome-Based Education (OBE), emphasizing the importance of achieving specific learning outcomes that are relevant to students' academic and professional aspirations. Through this system, the institution can continuously assess the impact of its educational practices and adapt them to better meet student needs.

TABLE 6. The relevant section for assessment in the SUFO

Section	Related questions on
A	Overall impression about the course
B	Lecturer professionalism
C	Teaching and learning activities
D	Infrastructure

RESULTS AND DISCUSSION

SECTION A: NUMBER OF STUDENTS FOR EACH SEMESTER

During the Covid-19 pandemic in semester 20214, a total of 40 students registered for Course X. To ensure smooth online class attendance and avoid scheduling conflicts, the students were divided into two groups, allowing each student to choose their preferred timetable. This arrangement aimed to accommodate the challenges posed by online learning during the pandemic. After the Covid-19 situation improved, two subsequent batches were formed. In semester 20224, 80 students were divided into four groups, while in semester 20234, 92 students were divided into five groups. In both batches, the class sizes were kept below 30 students to ensure effective teaching and allow lecturers to focus on each group's individual needs. Table 7 provides an overview of student enrollment and group distribution across semesters 20214, 20224, and 20234. It reflects the steady increase in student enrollment, as well as the effort to maintain manageable group sizes for effective learning.

TABLE 7. Enrollment and Group Distribution for Course X across Semesters 20214, 20224, and 20234.

Semester	Number of Students	Number of Groups	Average Group Size
Semester 20214	40	2	20
Semester 20224	80	4	20
Semester 20234	92	5	18.4
Total	212	11	-

With the transition to post-Covid-19 conditions, face-to-face learning was reintroduced, providing students with opportunities for in-person interaction and hands-on experiences. This shift aims to enhance the learning experience and promote a more comprehensive understanding of the subject matter. The adjustments made to class organization and the transition from online to face-to-face learning demonstrate the Civil Engineering program's adaptability in response to the challenges posed by the Covid-19 pandemic. The program's dedication to accommodating students' needs, maintaining manageable class sizes, and creating a conducive learning environment is evident through its continued success.

SECTION B: EVALUATION OF STUDENT'S ACADEMIC PERFORMANCE

DIAGNOSTIC TEST RESULT

The evaluation of student academic performance through diagnostic tests provides valuable insights into their existing knowledge and understanding of fundamental concepts. By analysing the data from these tests, educators can identify students' strengths and weaknesses, allowing them to design effective teaching strategies and interventions for the semester.

Figure 2 presents the performance analysis of diagnostic test results across three semesters: 20214 (Online Distance Learning - ODL), 20224 (Face-to-Face), and 20234 (Face-to-Face). The results are categorized into four grade levels: A, B, C, and Fail.

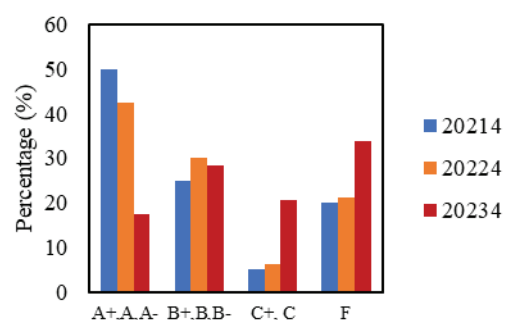


FIGURE 2. Performance analysis of diagnostic test results for semesters 20214, 20224, and 20234.

In semester 20214 (ODL), half of the students (50%) achieved grade A, indicating a strong understanding of fundamental concepts. A quarter of the students (25%) received grade B, showing a satisfactory grasp of the material. Only 5% of students earned grade C, suggesting

a small group requiring improvement. However, 12.5% of students failed the diagnostic test, pointing to the need for additional support and intervention.

During the following term, 20224, which marked the return to face-to-face learning, the percentage of students achieving grade A dropped slightly to 43%. About 30% obtained B grade, reflecting satisfactory performance by a significant portion of the cohort. Although the proportion of grade C remained relatively low at 6%, the failure rate increased to 21%, signaling a potential need to investigate student challenges in this format.

In the most recent assessment of 20234, performance declined further. Only 17% of students achieved grade A, a significant decrease from the previous semesters. Approximately 28% received grade B, while 21% earned grade C, highlighting an increase in the number of students struggling with the course content. The failure rate surged to 34%, the highest across the three terms, underscoring the urgent need for targeted interventions and support.

These diagnostic test results reveal varying trends in student performance over time. While semester 20214 (ODL) saw stronger outcomes, subsequent face-to-face semesters exhibited a gradual decline, particularly in 20234. The rising failure rate and increasing number of students needing improvement suggest a closer examination of the factors contributing to these shifts, such as the impact of transitioning back to in-person learning and potential changes in the curriculum or teaching methods.

Overall, these findings emphasize the need for continuous evaluation and the implementation of targeted support strategies to address the academic needs of students. By identifying areas where students struggle, educators can develop more effective intervention plans to enhance learning outcomes and ensure success throughout the semester.

CO-PO DISTRIBUTION

The alignment between Course Outcome 1 (CO1) and Program Outcome 1 (PO1), as well as between Course Outcome 2 (CO2) and Program Outcome 2 (PO2), is illustrated in Figure 3. This mapping ensures that the course outcomes (COs) directly contribute to the achievement of the program outcomes (POs), equipping students with essential skills and competencies relevant to their field. In

the overall CO-PO distribution for Course X, 25% of the weight is allocated to CO1-PO1. This signifies the importance of applying knowledge of physical and engineering properties in practical situations and procedures. The remaining 75% is allocated to CO2-PO2, reflecting the focus on identifying, analysing, and solving engineering problems, particularly in soil engineering, with substantiated conclusions.

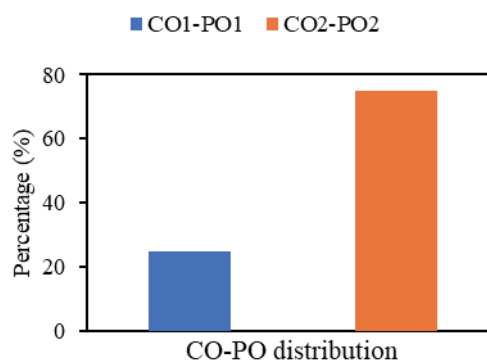


FIGURE 3. Overall CO-PO distribution

CARRY MARKS

The carry marks distribution for different semesters is illustrated in Figure 4(a, b). During semester 20214 (conducted entirely online), the carry marks comprised 10%, allocated equally between a quiz assessing CO1-PO1 (5%) and CO2-PO2 (5%). Attainment for CO1-PO1 was consistently high, exceeding 90% in all semesters, including the online term and the face-to-face terms that followed (20223 and 20234). However, the performance in CO2-PO2 showed a decline, dropping from 97% in the online semester to 86% during face-to-face learning sessions. When shifting focus to the 30% carry marks assessment, which included an individual assignment and a face-to-face test, a noticeable drop in performance across both CO1-PO1 and CO2-PO2 was observed. For CO1-PO1, attainment decreased from 86% during the online semester to 55% and 44% in the subsequent face-to-face terms (20223 and 20234, respectively). Similarly, for CO2-PO2, performance decreased from 65% in the online semester to 54% in 20223, with a slight improvement to 57% in 20234.

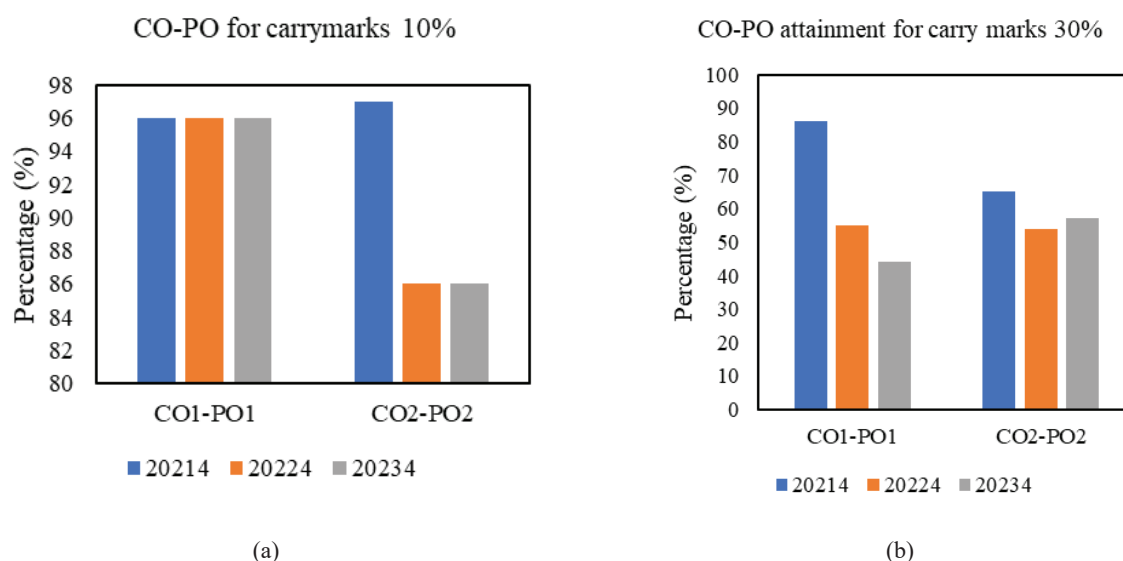


FIGURE 4 Overall CO-PO attainment for carry marks (a) 10% attainment (Quiz) and (b) 30% attainment (Assignment + test)

The observed decline in student performance for CO2-PO2 during face-to-face learning sessions compared to online semesters can be attributed to several interrelated factors. First, the transition from online to in-person learning often presents adjustment challenges for students who have adapted to the online format. Research indicates that many students struggle with re-engaging in traditional classroom settings after extended periods of remote instruction, which can lead to decreased motivation and engagement. For instance, a study by Azizi et al. (2023) highlights that students often experience heightened stress during assessments conducted in face-to-face environments, which can negatively impact their academic performance.

Additionally, the assessment formats used during face-to-face sessions such as individual assignments and in-person tests, may have been more rigorous than those conducted online. Moreover, face-to-face assessments tend to increase anxiety and pressure due to the presence of peers and instructors, which can further hinder performance. Abdul Malek et al. (2023) emphasize that these environmental factors can significantly impact student engagement and performance outcomes. Lastly, research by Mahlan et al. (2022) indicates that many students experienced a decline in performance when shifting from online to face-to-face assessments due to various factors including increased anxiety and changes in assessment rigour. To optimize student outcomes, educational institutions may benefit from adopting blended learning models that combine the strengths of both online and face-to-face instruction.

FINAL EXAM

The CO-PO attainment for the final exam, as shown in Figure 5, reveals notable variations in student performance across different semesters.

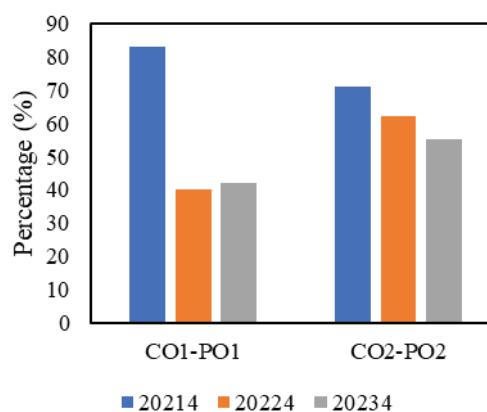


FIGURE 5. CO-PO attainment for the final exam

In semester 20214, the traditional format of the final exam was replaced with two online tests. The attainment for CO1-PO1 was recorded at 83%, while CO2-PO2 achieved 71%. A study by Santiago et al. (2021) highlighted a significant improvement in student performance during emergency remote teaching, noting that factors such as class size, the mode of delivery (synchronous versus asynchronous), and the choice of virtual communication tools have minimal impact on overall student outcomes.

However, the online assessment format presented challenges in ensuring academic integrity and strict monitoring, which could potentially affect student performance. To uphold academic integrity, measures were implemented, including requiring students to complete integrity declaration forms and keeping their cameras on during exams. Nevertheless, the sheer number of students being monitored online has made it difficult to fully guarantee compliance with the rules.

In contrast, during semesters 20224 and 20234, face-to-face final exams were administered, constituting 60% of the overall assessment. The attainment for CO1-PO1 declined to 40% in semester 20224 but slightly increased to 42% in semester 20234. Similarly, the attainment for CO2-PO2 decreased to 62% in semester 20224 and further declined to 55% in semester 20234.

It is crucial to recognize that the different assessment formats have likely influenced student preparation and performance. The online assessment in semester 20214 was divided into two tests, each focusing on specific chapters. This division may have led to less comprehensive studying, as students are not required to synthesize information across the entire syllabus. Conversely, the face-to-face final exam necessitates a thorough understanding of all course materials, covering the entire syllabus.

The observed results suggest that student performance varies significantly across different assessment formats. While the online assessments in semester 20214 posed challenges in ensuring academic integrity, they provided students with a more flexible and enjoyable learning experience, allowing for convenient study times. This notion is supported by Nasir and Mukhtar (2024) who found that utilizing instructional resources, such as textbooks and videos, has made it feasible to engage with students beyond the confines of the classroom and during evening hours.

In contrast, the face-to-face final exams in semesters 20224 and 20234 required the students to demonstrate their knowledge of the entire course material. The variations in assessment formats and coverage have likely contributed to the observed differences in student performance, underscoring the need for careful consideration when designing assessments in future courses.

CO-PO ATTAINMENT TRENDS ACROSS SEMESTERS

The attainment of Course Outcomes (CO) and Program Outcomes (PO) across different semesters reveals noteworthy trends, as depicted in Figure 6. In semester

20214, the attainment for CO1-PO1 was recorded at 86%, while CO2-PO2 achieved 71%.

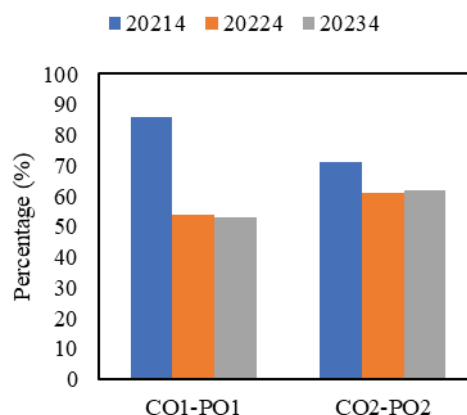


FIGURE 6. CO-PO Attainment rates by semester

However, during the face-to-face assessments in semesters 20224 and 20234, there was a significant decline in CO-PO attainment. For CO1-PO1, the attainment decreased to 54% in semester 20224 and further declined to 53% in semester 20234. Similarly, for CO2-PO2, the attainment dropped to 61% in semester 20224 and then experienced a slight increase to 62% in semester 20234.

The performance data for CO1-PO1 in semester 20214 indicated an “excellent” level of achievement, reflecting a strong understanding of the program outcomes. However, this performance declined in semester 20224, landing within the “good” range. The trend continued in semester 20234, where the score slightly decreased but remained within the “good” range.

In semester 20214, student performance in CO2-PO2 fell into the “good” category, albeit not reaching the “excellent” threshold. Similar to CO1-PO1, there was a slight decline in performance in semesters 20224 and 20234, with scores remaining relatively consistent within the “good” range.

The drop in CO-PO attainment from online assessment to face-to-face evaluation can be attributed to various factors, including differences in assessment formats, changes in the learning environment, and the challenges associated with in-person examinations. Online assessment provides greater flexibility and access to open-book resources, while face-to-face assessment necessitates that students demonstrate their understanding within a limited timeframe and under strict supervision.

A study conducted by Masyitah and Duratul (2022) explored how various factors influence students’ academic performance. These factors included the total number of assessments administered during the semester, the teaching

and learning methodologies employed, the methods of conducting examinations, and the allocation of student learning time for both face-to-face and non-face-to-face approaches.

OVERALL CO-PO SCORES EXCEEDING 50%

Evaluating the performance of the engineering program necessitates a focus on key performance indicators (KPIs) that are based on the program outcomes (POs). These KPIs provide a comprehensive framework for assessing the program's effectiveness. Achieving CO-PO scores above 50% is vital, as it serves as an indicator of satisfactory student performance. This requirement ensures that students demonstrate their understanding and competence in the subject matter.

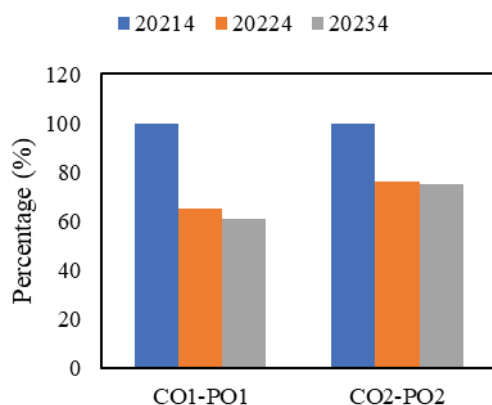


FIGURE 7. Distribution of overall CO-PO scores exceeding 50%

As illustrated in Figure 7, the distribution of CO-PO scores exceeding 50% is observed in two categories: CO1-PO1 and CO2-PO2, measured at the end of each semester for Course X. For CO1-PO1, the percentage of students achieving scores above 50% was 100% in the semester of 20214. However, this figure decreased to 65% in the 20224 semester and further declined to 61% in the 20234 semester. Similarly, for CO2-PO2, the percentage of students scoring above 50% was also 100% in the 20214 semester but fell to 76% in the 20224 semester and slightly decreased to 75% in the 20234 semester.

These findings align with several studies confirming the positive impact of digital platforms in enhancing various learning outcomes (Akbari et al. 2021; Jusue et al. 2021; Santiago et al. 2021; Lapitan et al. 2021; Elfaki et al. 2021). Moreover, this beneficial effect has been evident not only under normal circumstances but also during the Covid-19 pandemic, as digital platforms have continued

to facilitate improved learning outcomes (Alshammary & Alhalafawy, 2022; Alanzi & Alhalafawy, 2022).

It is essential to emphasize that maintaining strong program performance necessitates that all students achieve a minimum of 50% in program outcomes for each subject. This standard ensures that students acquire the requisite knowledge and skills necessary to meet the program's requirements successfully.

GRADING SCORE

Analysing student grades for Course X reveals noteworthy trends across different semesters, as illustrated in Figure 8. During the 20214 semesters, which was conducted online and did not include a final exam, the distribution of grades was relatively balanced. Approximately 50% of students achieved grade A, while the remaining 50% received grade B, indicating a satisfactory level of performance under the unique circumstances of the online learning environment. Analysis of student grades for Course X reveals noteworthy trends, particularly in the 20214 semester, which was conducted entirely online without a final exam. During this semester, the grade distribution was relatively balanced, with approximately 50% of the students achieved grade A and the remaining 50% received grade B. This outcome indicates a satisfactory level of performance among the students, given the unique circumstances of the online learning environment.

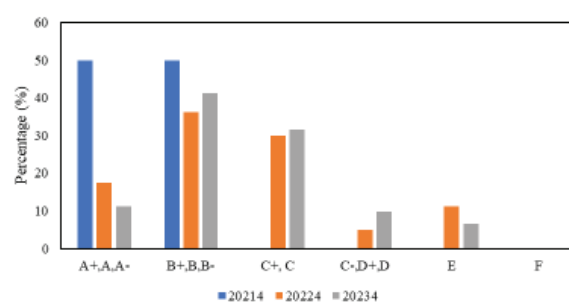


FIGURE 8. Student's grade achievement for Course X

In contrast, the subsequent semesters of 20224 and 20234 employed traditional teaching methods with strict assessments, leading to a noticeable shift in grade distribution. In the 20224 semester, the percentage of students attaining grade A dropped to 18%, while those receiving grade B increased to 36%. Approximately 30% of the students earned grade C, reflecting a decline in performance compared to the previous semester, and around 16% of students failed the course. This downward trend continued into the 20234 semester, with further

decline: only 11% of students achieved grade A, while the percentage receiving grade B increased to 41%. The proportion of students who earned grade C remained stable at 32%, with about 17% failing the course.

Several advantages of online learning may have contributed to the improved student performance in the 20214 semester. One significant benefit is the flexibility it offers, allowing students to study anywhere and at any time. This flexibility enables them to create personalized learning environment tailored to their preferences and schedules. Furthermore, students participating in online classes generally feel more comfortable using technology and various applications on their devices, enhancing engagement and overall learning experience. Conversely, in a traditional classroom setting, students who miss classes may struggle to catch up, especially when the content involves complex calculations or step-by-step processes. This difficulty can hinder their understanding of the material and potentially lead to higher failure rates. Additionally, some students may hesitate to seek help from instructors in a face-to-face environment, further impeding their ability to clarify doubts and grasp key concepts effectively. Online classes provide the advantage of recorded lectures, allowing students who cannot attend live sessions to access the content later at their convenience. This feature enables them to review challenging topics and reinforce their understanding. The availability of recorded lectures can be particularly beneficial for those who need extra time to absorb and comprehend the material. These factors, coupled with the convenience of recorded lectures, create a conducive learning environment that supports student success.

Khan et al. (2021) noted that virtual and online learning experiences are engaging and enjoyable, thereby motivating both students and educators. Additionally, Rahiem (2021) found that students remain motivated and committed to their studies despite the challenges posed by the Covid-19 pandemic. Considering these factors, it is evident that the online learning environment provides distinct advantages that positively influence student performance in 20214 semester. The flexibility to study anytime and anywhere, along with the comfort and familiarity with technology, contributes to enhanced engagement and understanding.

ANALYSIS OF PERFORMANCE DECLINE

The transition from online learning to face-to-face assessments is likely a key factor in the variations of performance. Several potential reasons for these differences include:

1. **Assessment Format:** The change in evaluation method, from online quizzes and assignments to in-person tests, may have impacted student performance, particularly those accustomed to online learning.
2. **Learning Environment:** Online learning offers more flexibility in which some students may have found to be advantageous. Conversely, returning to a traditional classroom setting may have posed challenges in adapting to the more structured environment.
3. **Face-to-Face Interaction:** In face-to-face setting, the real-time nature of instruction and assessment might have created additional pressure or required quicker adaptability for students, particularly those who use asynchronous online learning.
4. **Time Management:** Shifting from online learning, which allows more flexible scheduling, to a more rigid timetable in face-to-face learning could have impacted students' ability to manage time effectively during assessments.

The observed drop in performance highlights the need to consider these factors when analysing student outcomes. While the decline is not drastic, it does indicate a shift in student adaptation and possibly underscores the challenge faced during the transition from online to face-to-face learning.

It is important to consider the teaching, learning and assessment methods used during the different learning modes. Traditional face-to-face (F2F) learning involves synchronous interaction between instructors and students in a physical classroom, allowing for real-time discussions and lectures. In contrast, online learning provides flexibility, with both live lectures and pre-recorded content available for students to access at their convenience.

The method of assessment also plays a role in shaping the performance. In purely online courses, assessments can be more flexible, while face-to-face learning emphasizes immediate feedback and interaction. The drop in performance following the shift from online to face-to-face assessments underscores the unique circumstances and challenges faced by students during this transition.

In summary, the differences in performance between the online and face-to-face semesters point to the need for continuous reflection and adjustment in teaching methods and assessments. Educators must remain mindful of these factors to enhance student learning outcomes, ensuring that the mode of delivery aligns with the needs and capacities of students across various learning environments.

SECTION C: GAP ANALYSIS BETWEEN DIAGNOSTIC TEST RESULT AND OVERALL STUDENT PERFORMANCE

FAILURE RATES AND A-GRADE EVALUATION

The disparity between diagnostic test results and overall student performance, particularly regarding failure rates and grade A, offers valuable insights into student progress and areas needing improvement. The diagnostic test serves as a crucial tool for assessing students' foundational knowledge of the subject, enabling lecturers to monitor performance and identify weaknesses effectively. Recent studies have emphasized the importance of diagnostic assessments in providing insights into learners' strengths and weaknesses (Berk, 2020; McMillan, 2022).

To illustrate this point, the failure rates across three semesters are presented in Figure 9. In the 20214 semesters, which utilized online evaluation through Open and Distance Learning (ODL), the diagnostic test indicated a 20% failure rate, while the overall failure rate was remarkably low at 0%. However, in the subsequent semesters, which employed traditional face-to-face assessment methods (20224 and 20234), the diagnostic test failure rates increased to 21% and 34%, respectively. Notably, the overall failure rates for these semesters remained constant at 16%. This data underscores the shifting dynamics in student performance as they transitioned from an online learning environment to a more structured conventional classroom setting.

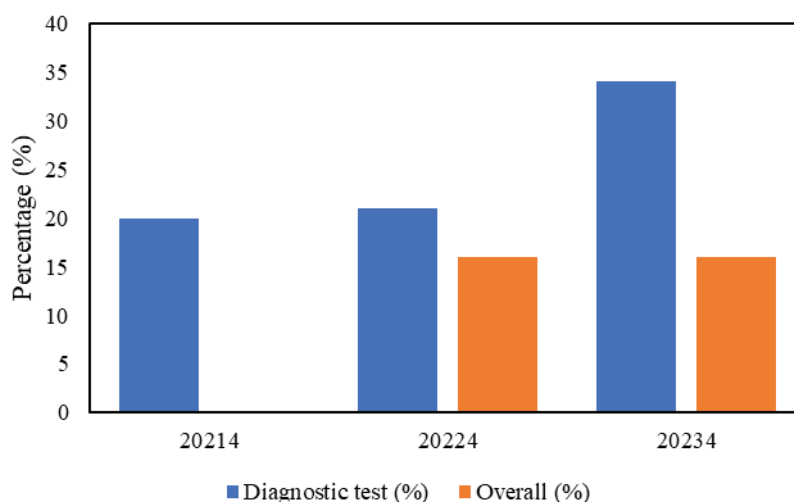


FIGURE 9. Failure rates in diagnostic tests compared to overall course performance

Grade A rates for three consecutive semesters are illustrated in Figure 10. In the 20214 semester, the diagnostic test indicated 50% grade A rate, which is aligned with the overall A grade rate. However, during the subsequent semesters of face-to-face conventional assessments (20224 and 20234), grade A rates from diagnostic tests decreased to 42.5% and 17.4%, respectively, while the overall grade A rates dropped to 17.5% and 10.9%. This decline in grade A rate can be attributed to several challenges that students face when transitioning from flexible online learning environment to a more structured conventional learning method.

The shift to face-to-face classes introduced compulsory attendance, a lack of recorded lectures for revision, and potentially fatigue from morning classes, all of which may have adversely impacted student performance. It is

essential to consider additional factors that might have contributed to these changes. The analysis underscores the critical role of diagnostic tests in identifying areas of weakness and monitoring student performance effectively. The discrepancies observed between diagnostic test results and overall student performance, particularly in failure rates and grade A rates offer valuable insights for educators. These insights enable the lecturers to address specific student needs and implement targeted interventions.

Notably, gap analysis reveals a positive trend in reducing failure rates when comparing diagnostic test outcomes with overall performance metrics. For instance, in the 20214 semester, failure rates decreased significantly by about 100%, dropping from 20% in the diagnostic test to 0% in overall performance. Similarly, in the 20224 semester, failure rates decreased by approximately 24%,

with a notable reduction exceeding 50% when comparing diagnostic test results with overall performance.

These findings highlight the effectiveness of lecturers' efforts in addressing weaknesses identified through diagnostic testing. They also demonstrate how understanding course content and syllabus can be enhanced through targeted interventions and instructional support provided to students. As noted by Abdi (2020), hands-on learning experiences significantly impact student engagement and

understanding in STEM education, reinforcing the importance of tailored instructional strategies based on diagnostic feedback. Overall, this analysis emphasizes the importance of diagnostic tests in informing instructional practices and facilitating student success. By leveraging insights gained from gap analysis, educators can continuously identify areas for improvement and implement strategies to enhance student performance effectively.

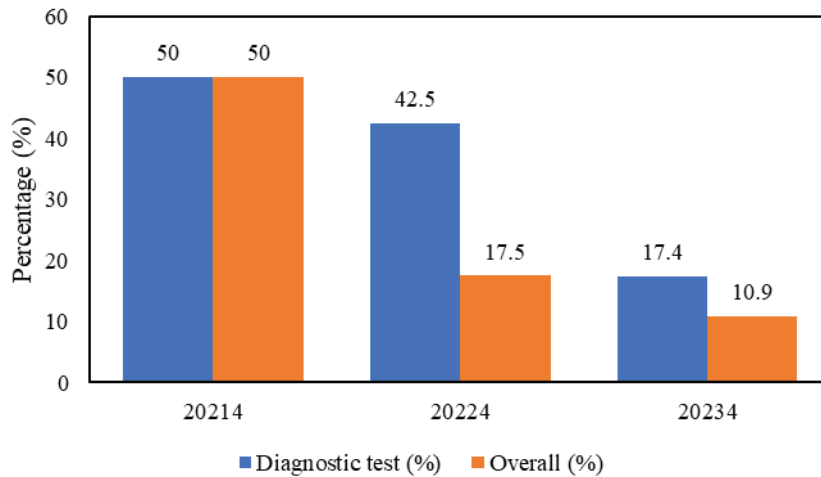


FIGURE 10. Comparison of grade 'A' rates between the diagnostic test and overall course

SECTION D: STUDENTS' FEEDBACK VIA STUDENT'S FEEDBACK ONLINE (SUFO)

Table 8 presents the results of Student Feedback Online (SUFO) analysis for Course X, which evaluates student perceptions across four key categories: A) Overall impression about the course, B) Lecturer professionalism, C) Teaching and learning activities, and D) Infrastructure. The data indicated a positive trajectory in students' knowledge and confidence levels over the semesters of 20214, 20224, and 20234, with overall ratings of 3.46, 3.63, and 3.67 out of a maximum score of 4. This consistent increase in ratings suggests that the course has effectively contributed to enhancing students' knowledge base.

The upward trend in ratings across all categories highlights the course's relevance to students' fields of study. The alignment between course content and students' academic pursuits is critical, as it ensures that the knowledge gained is both applicable and beneficial to their chosen disciplines. Research by Hernandez Cardenas et al. (2021) supported this notion, emphasizing that personalized learning models significantly enhance academic levelling by tailoring educational experiences to meet student needs. Raihana et al. (2021) found that ODL offers flexibility that

positively influences student satisfaction during remote learning. However, they also noted that students prefer the interaction afforded by face-to-face learning, which aligns with the improved scores observed for post-pandemic. A study by Mahmood et al (2012) & Khan and Zia (2023)

demonstrated that transitioning back to traditional classroom settings leads to higher student satisfaction scores, echoing the upward trend seen in Course X's SUFO analysis. Additionally, research by Joshi et al. (2023) highlighted that blended learning approaches significantly enhance student engagement compared to purely online or traditional methods. This finding resonates with the positive feedback trends observed in Course X as it transitioned from ODL to face-to-face instruction.

Furthermore, the assessment methods employed in the course play a pivotal role in fostering students' learning abilities. The positive feedback reflects the effectiveness of these assessments in motivating students to engage actively with course materials and apply their knowledge meaningfully. As noted by Mavridis and Koutouzis (2020), effective assessment strategies are essential for promoting student engagement and improving academic outcomes.

TABLE 8. Student's feedback online (SUFO) analysis for Course X

	SUFO Analysis				
	A	B	C	D	Overall
20214	3.48	3.43	3.46	3.46	3.46
20224	3.61	3.61	3.63	3.67	3.63
20234	3.65	3.68	3.68	3.67	3.67

Based on the data provided in Figure 11, it is evident that the course has a positive impact on students' overall knowledge and confidence levels. The ratings for the course in the respective years of 20214, 20224, and 20234 were 3.48, 3.61, and 3.65 out of a maximum score of 4. These ratings indicate that the course is consistently effective in increasing students' knowledge. The fact that the ratings have shown a gradual increase over the years suggests that the course has been successful in providing relevant and valuable information to the students. The course seems to be closely related to the student's field of study. This alignment between the course content and the student's academic pursuits is crucial in ensuring that the knowledge

gained is applicable and beneficial to their chosen discipline. In terms of the assessment method, it is evident that it plays a significant role in enhancing students' learning abilities.

The positive ratings reflect the effectiveness of the assessment method in encouraging students to actively engage with the course material and apply their knowledge in a meaningful way. The data suggests that the course has a positive impact on students' knowledge, confidence, and learning abilities. The consistent increase in ratings over the years is a testament to the course's effectiveness in providing valuable information and fostering a conducive learning environment.

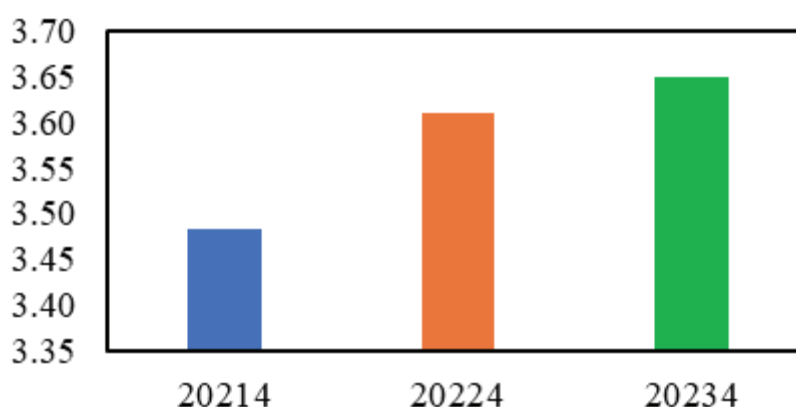


FIGURE 11. Student feedback on the overall impression of Course X in SUFO.

According to the data provided in Figure 12, it is evident that the lecturer consistently demonstrates a high level of professionalism throughout the teaching and learning process. The ratings for lecturer professionalism in the years 20214, 20224, and 20234 were 3.43, 3.61, and 3.68, respectively. These increasing ratings indicate that the lecturer is successful in completing scheduled instructional hours and providing academic guidance to students. The consistent rise in ratings over the years suggests ongoing improvements in professionalism and

effectiveness in these areas. Additionally, these ratings indicate that the lecturer is approachable, allowing students to seek clarification, guidance, and support when needed. The ability to easily approach and contact the lecturer fosters a positive learning environment and encourages active student engagement. The data demonstrates that the lecturer consistently exemplifies professionalism across various aspects of teaching. These qualities contribute significantly to a positive learning experience and highlight the lecturer's commitment to their role as an educator.

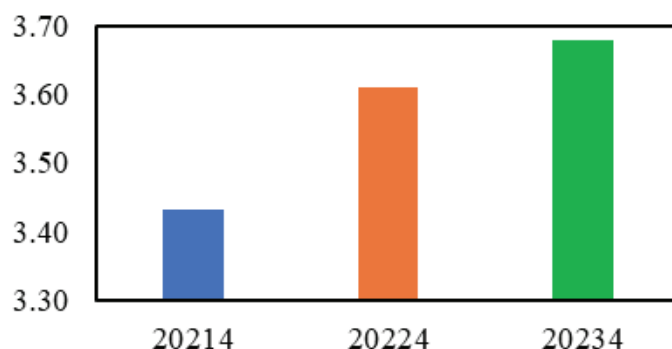


FIGURE 12. Student feedback on lecturer professionalism for Course X in SUFO.

SECTION E: TEACHING AND LEARNING ACTIVITIES

Figure 13 presents a positive trend in student rating for teaching and learning activities, demonstrating the effectiveness of the lecturer's approach. The data revealed a consistent upward trajectory, with ratings rising from 3.46 out of 4 in 2021 (during the COVID-19 pandemic) to 3.63 out of 4 in 2022 and 3.68 in 2023 (post-COVID). This indicates that the lecturer's teaching methods are well-received and foster a positive learning environment. The

lecturer's dedication towards active student engagement is reflected in the data, demonstrating a positive impact on student learning. By fostering an inclusive and engaging environment, the lecturer encourages participation, cultivates collaboration, and instills a sense of ownership in the course material. This approach contributes to the high-quality educational experience reflected in the student ratings. Research by Northey et al. (2018) suggested that students learn more effectively when they are actively engaged in the learning process and can connect course content to their own lives and interests.

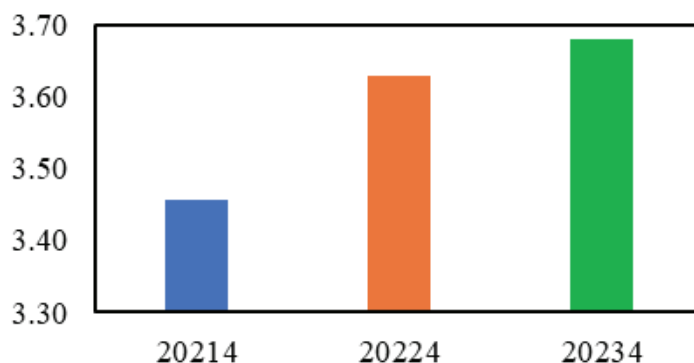


FIGURE 13. Student feedback on teaching and learning activities for Course X in SUFO

The lecturer's teaching excellence is maintained even during the challenging period of the COVID-19 pandemic in 2021. This demonstrates their adaptability to online teaching and ability to overcome obstacles to ensure effective learning. This finding aligns with the importance of teacher support in any circumstances, as highlighted by Vermunt and Donche (2017). The lower rating during 2021 compared to the post-COVID rating suggested that universities should prioritize equipping students with the skills and resources to learn independently through various

methods. Proactive planning for remote learning is essential to ensure educational continuity in the challenging circumstances (Rahiem, 2021). Additionally, the implementation of Internet of Things (IoT) technology offers a potential avenue for improving learning experiences and addressing the challenges posed by pandemics (Muhamad et al. 2023). In summary, a lecturer's commitment to deliver high-quality teaching and learning activities is crucial during online or conventional T&L. The positive ratings, both during the challenging period of

Covid-19 and in the post-Covid era, reflect the lecturer's ability to engage students and create an enjoyable learning experience. These findings emphasize the significance of teacher support and proactive planning to ensure effective education in any circumstances.

In Figure 14, the ratings pertain to the infrastructure of the learning environment, specifically the equipment and space available for teaching and learning purposes, as

well as the adequacy and functionality of the learning equipment. The data revealed variations in the ratings across different periods. In 20214, the rating was 3.46, while in 20224 and 20234, the ratings increased to 3.67 and 3.67 respectively. These ratings indicated that during online learning, the ratings are comparatively lower, potentially due to the challenges encountered during the learning process.

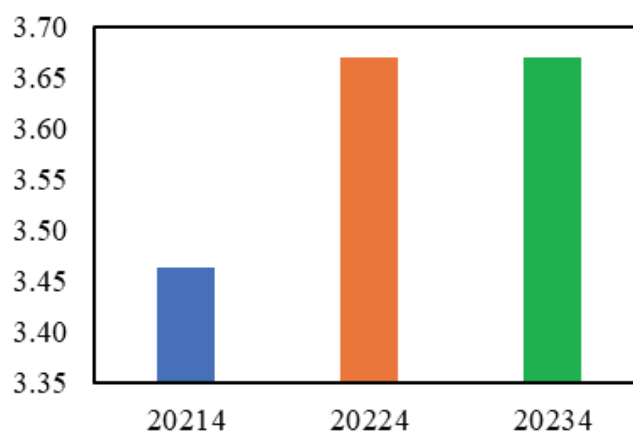


FIGURE 14. Student feedback on infrastructure provided by the University for Course X in SUFO.

One possible factor contributing to the lower ratings during online learning is the lack of adequate equipment at home. Students may face difficulties in accessing the necessary learning tools and resources, which can impact their learning experience and hinder their ability to fully engage in the online coursework.

Furthermore, the presence of disturbances caused by crowded home environments can also contribute to the lower ratings during online learning. With multiple individuals sharing the same space, students may struggle to find a quiet and conducive environment for focused learning. These disruptions can affect their concentration and overall learning outcomes. This observation is supported by Assunção and Gago (2020) who found that many students did not have the required devices, internet access, or resources needed for remote online studying. Additionally, Rasmitadila et al. (2020) noted that some learners and educators are unfamiliar with the digital platforms and online programs required for remote learning.

Kapasias et al. (2020) examined the impact of the Covid-19 lockdown on undergraduate and postgraduate students from various colleges and universities which found that students, particularly those from remote areas and disadvantaged backgrounds, faced various challenges related to depression, poor network connectivity, and an unfavourable home study environment. Conversely, the

higher ratings during conventional learning can be attributed to the infrastructure provided by the university. In a traditional classroom setting, students have access to well-equipped facilities and a dedicated learning environment. This allows them to concentrate on their studies without the distractions often encountered in a home-based learning environment.

In Figure 16, the graph represents the overall performance rating after summarizing the data from sections A, B, C, and D. The ratings for the respective periods are as follows: 20214 with a rating of 3.46, 20224 with a rating of 3.63, and 20234 with a rating of 3.67. These ratings provide a comprehensive assessment of the overall performance of the course, lecturer, teaching and learning activities, and infrastructure of the learning environment. They reflect the student's overall perception and satisfaction with these aspects.

The data reinforced the findings from the individual sections, indicating that the overall performance is positive and satisfactory. It suggests that the course effectively increases students' knowledge and confidence, and the teaching and learning activities are engaging and aligned with the students' needs. The infrastructure provides a conducive learning environment, supporting the students' learning experience. This finding is supported by the study of Yangambi (2023), which emphasized that adequate infrastructure in educational settings significantly impacts

student performance and achievement. He highlighted that a well-designed learning environment fosters better engagement and comprehension among students, directly contributing to improved academic outcomes. Additionally, Hernandez et al. (2021) pointed out that personalized learning models, supported by quality infrastructure, are

critical in levelling academic disparities and boosting student success. These studies collectively underscore the importance of adequate educational infrastructure in creating a supportive learning atmosphere that benefits student performance.

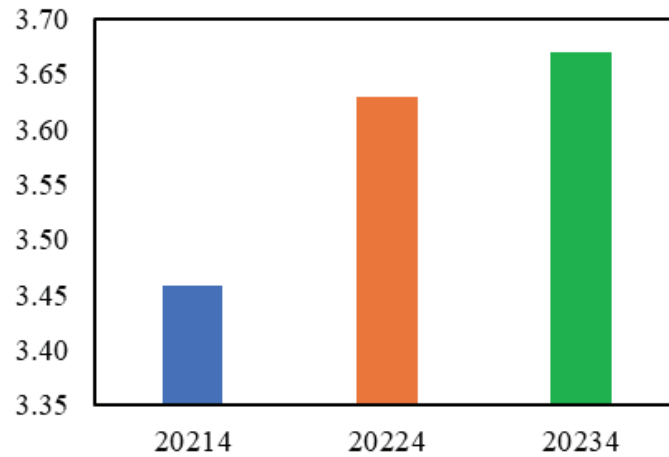


FIGURE 15. Student feedback on overall performance indicator for Course X in SUFO.

The findings from this study suggest several implications for future course designs in engineering education, particularly in the context of Continuous Quality Improvement (CQI):

1. **Course Design Adaptations:** The positive results from diagnostic tests during Open Distance Learning (ODL) highlight the effectiveness of online assessments in identifying student needs early in the course. Future designs could incorporate blended approaches that combine online diagnostic testing with traditional face-to-face instruction.
2. **Continuous Quality Improvement (CQI):** The different feedback scores of post-Covid suggest that while traditional methods may enhance certain aspects of student engagement or satisfaction, there remains an opportunity for CQI initiatives to refine teaching strategies based on ongoing student feedback.
3. **Holistic Assessment Strategies:** The analysis reinforces the importance of employing a variety of assessment types to capture a comprehensive view of student learning outcomes. Future engineering education should consider integrating diverse assessment methods that align with both Course Outcomes (COs) and Program Outcomes (POs) while fostering an environment conducive to continuous improvement.

4. **Future Research Directions:** Further research could explore long-term trends in student performance across different instructional modalities beyond immediate contexts like Covid-19, providing insights into effective practices for engineering education.

CONCLUSION

This study has thoroughly evaluated the academic performance of students enrolled in Course X at the School Department of University A, comparing outcomes between ODL and conventional teaching methods. Data collected over three semesters revealed significant achievements in course assessments, particularly in CO1-PO1 and CO2-PO2. During the online semester, students exhibited outstanding performance, achieving high percentages and a substantial number of grade A result, with no recorded failures. These findings highlight the effectiveness of the flexible ODL approach, especially during the challenging circumstances brought on by the Covid-19 pandemic. However, evaluations of CO-PO attainment in traditional classroom settings indicated satisfactory results but also pointed to areas for improvement. To effectively implement CQI based on these findings, course coordinators and educators should take specific actionable steps:

1. Regular Data Analysis: Establish a routine for analysing performance data to identify trends and areas needing enhancement.
2. Feedback Mechanisms: Create structured channels for students to provide feedback on their learning experiences and challenges in ODL and conventional settings.
3. Professional Development: Offer ongoing training for educators on best practices in blended learning and student-centered approaches to enhance teaching effectiveness.
4. Curriculum Alignment: Ensure course content is consistently aligned with ETAC accreditation standards by regularly reviewing and updating learning objectives based on assessment outcomes.
5. Pilot Programs: Implement pilot blended learning initiatives to evaluate their impact on student engagement and performance before broader adoption.

Looking ahead, promoting flexible methods such as ODL and blended learning alongside student-centered approaches aims to empower both educators and students to actively engage in the learning process, thereby fostering improved student performance and overall learning outcomes. This study underlines the importance of CQI, CO-PO evaluation, and student performance analysis in enhancing the quality of both the course and program. By utilizing data and feedback from both the Covid-19 period and post-Covid context, educators can continuously refine their teaching strategies to meet the evolving needs of students, ensuring a high-quality learning experience in both ODL and conventional settings.

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DECLARATION OF COMPETING INTEREST

None.

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