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Continual Quality Improvement in the Assessment of Programme Outcomes in the Engineers and Society Course Integrating SULAM in Malaysia

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Abstract— Service-learning courses, aimed at enhancing students' skills in community activities receive insufficient attention, particularly regarding continual improvement in the assessment aspects within engineering education. This paper presents the continual quality improvement (CQI) in assessment tools used in the Engineers in Society (EIS) course, which integrates a pedagogy known as SULAM (Service-Learning Malaysia University for Society) at a Malaysian engineering programme. The objective of this study is to assess the current CQI actions focusing on the assessment tools for a selected engineering course. A mixed-method approach was employed, consisting of a survey questionnaire administered to 462 final-year civil engineering students taking the EIS course and a document review of course files to analyze lecturers' suggestions for improving assessment tools. The feedback from the survey shows that most students agreed that the assessment tools are effective. In addition, a longitudinal review was carried out on six (6) cycles of CQI actions (October 2019 to October 2022 semesters), where students' performance has shown positive trends based on the improvements in two (2) programme outcomes, PO6 (Engineers & Society) with the highest average attainment of 89% and 78% for PO8 (Ethics & Professional Conducts), respectively, highlighting the effectiveness of course assessment tool modification. However, there is a need for further improvement in the assessment tools, particularly to assess PO8. The skewed distribution of grades towards A grades reflected that rubric needs further refinement as an effective assessment tool. Overall, the study provides valuable insights into the challenges and opportunities in the education system and emphasizes the importance of CQI to ensure that students are well-equipped to become responsible public intellectuals capable of addressing society's challenges.

Keywords—continual quality improvement; engineers in society; learning and assessment; programme outcomes.

1. Introduction

In recent years, experiential learning has emerged as an important educational approach within engineering disciplines, where the integration of practical, real-world experiences into academic curricula related to community service-learning is

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increasingly valued. This pedagogical shift is driven by the need to equip students with the technical skills and societal understanding necessary for addressing contemporary challenges. Despite its growing adoption, previous studies reveal some shortfalls in the improvement of assessment methodologies with the learning outcomes in engineering programmes.

Some attention has been given to service-learning courses as researchers endeavor to identify effective practices for assessing student learning and evaluating its impact on the community (Bringle & Hatcher, 1996). Moreover, another study highlighted the potential of service-learning as an innovative and effective approach within the landscape of engineering education (Isa et al., 2022). In Malaysia, the higher education curriculum incorporates a community service-learning method known as SULAM (Service-Learning Malaysia-University for Society) (Ministry of Higher Education, 2019). SULAM is designed to provide students with meaningful experiences in community service by actively engaging with the community to address real-world problems using the knowledge and skills they acquire through their coursework. Integrating real-world, hands-on experiences into the engineering curriculum significantly enhanced practical learning, resulting in a 15% improvement in complex engineering problem-solving skills compared to traditional classroom instruction (Bhatt et al., 2024). One of the key components of SULAM is the introduction of a core course that deviates from the traditional approach of lectures and tests. Instead, it adopts a blended learning format with alternative assessments, placing a greater emphasis on active student engagement and problem-solving. As this innovative approach is implemented, it becomes crucial to gather feedback on the teaching, learning, and assessment (TLA) processes. To ensure the continuous improvement of SULAM implementation, regular quality improvement actions are undertaken. These actions are aimed at refining and enhancing the effectiveness of the SULAM approach, making it a dynamic and evolving method for engaging students in community service and promoting their learning and development.

The assessment of service-learning courses, particularly in the field of engineering, remains relatively understudied, especially regarding the evaluation of technical skills gained by the students. While previous research done by Chan (2012) investigated the assessment methods for experiential learning and Queiruga-Dios et al. (2021) explored assessment in service-learning courses for engineering students, these studies focused on broader learning outcomes or non-technical skills. This gap highlights the need for assessment methods that specifically evaluate the application of engineering knowledge and skills acquired through service-learning experiences. Thus, this paper addresses the research gap by enhancing the assessment frameworks through continual quality improvement (CQI) in the Engineers in Society (EIS) course of the Civil Engineering programme in Malaysia. This study focuses on aligning assessments with the learning outcomes of experiential learning in engineering, particularly by incorporating student recommendations for improved assessment tools.

A combination of quantitative surveys to gather data on student perceptions, and qualitative approach via document analysis to assess CQI effectiveness is adopted. These research methods have proven to be effective in providing a holistic view of SULAM implementation, offering insights into its strengths, weaknesses, and areas for improvement. Preliminary results suggest a positive impact on student engagement and learning outcomes, highlighting the value of SULAM in education.

To further explore the impact and effectiveness of SULAM implementation, this study addresses the following research questions:

Research Question 1: What are the key challenges faced in implementing SULAM, and how can they be addressed?

Research Question 2: How do SULAM assessments impact student learning outcomes and engagement?

Research Question 3: What are the most effective mechanisms for continuous improvement in SULAM?

This paper is structured as follows: A background study was presented followed by the literature review section that provides overviews on the community service learning known as SULAM (Service-learning Malaysia University for Society) and the implementation of continual quality improvement (CQI) in teaching, learning and assessment. The methodology section explains the mixed method that combines the quantitative and qualitative approaches that allows for a deeper exploration of the CQI aspects

that are related to assessment tools in the EIS course and shedding light on areas that require improvement and areas that have been successful. It also outlines the questionnaire sections prepared for data collection, the types of direct assessment tools employed, and the review of relevant documents. The data analysis and results segment present the findings derived from the analysis of the collected data and discusses the effectiveness of the assessment tools for learning experiences in the EIS course. The analysis on the students' programme outcome's direct attainment from the course is also presented together with the assessment of the CQI action plans to improve the overall students' achievements. Lastly, the conclusions and future recommendations are presented.

2. Literature Review

A. Service-learning Malaysia University for Society (SULAM) Pedagogical Approach

SULAM pedagogy is a highly impactful educational practice introduced by the Department of Higher Education of Malaysia in 2015. It is a university-level course that incorporates structured service activities, grounded in community needs analysis. In the SULAM course, students actively participate in a diverse range of activities, aimed at providing them with a comprehensive understanding of the subject matter. These activities directly target the acquisition of content knowledge aligned with community service-learning outcomes. Additionally, the course offers valuable benefits such as fostering civic consciousness and enhancing personal qualities.

One of the theoretical foundations of SULAM lies in experiential learning, which emphasizes the acquisition, manipulation, and recall of abstract symbols, encompassing conscious and subjective experiences in the learning process. This stands in contrast to behavioral learning theories that rely solely on empirical evidence and rational idealist epistemology (Kolb, 2015). Furthermore, SULAM embraces constructivism, a learning theory where students actively connect their personal experiences with the taught content. This approach acknowledges that individuals construct their own knowledge based on their learning experiences and emphasizes hands-on activities to engage the mind (Chand, 1995). The integration of the SULAM approach within the EIS course allows students to explore the intricate values and systems of society through structured experiential learning. By actively engaging in these experiences, students develop a deeper understanding of societal dynamics and gain essential skills for responsible engineering practice.

B. Outcome-based Education and Board of Engineers Malaysia

Outcome Based Education (OBE) approach is required by the Engineering Accreditation Council (EAC), Board of Engineers Malaysia (BEM) to be implemented in all engineering programmes. Two (2) important elements in OBE approach are the programme educational objectives (PEO) and programme outcomes (PO), which must be continually reviewed and their achievement measured within a certain time frame as part of the quality assurance process (Abdullah et al., 2009).

In the EAC Standard 2020, PEOs are specific statements/goals consistent with the mission and vision of the IHL, responsive to the expressed interest of programme stakeholders, and describe the expected achievements of graduates in their career and professional life a few (3 to 5) years after graduation. POs, on the other hand, describe what students are expected to know and be able to perform or attain by the time of graduation. These relate to the skills, knowledge, and behavior that students acquire through the programme curriculum (Board of Engineers Malaysia, 2020). Engineering programmes in Malaysia fall under the purview of Board of Engineers Malaysia (BEM). which requires the attainment of twelve (12) programme outcomes.

It is vital for lecturers and students to visualize the relevance of programme outcomes (POs) in achieving the programme educational objective (PEOs) of the civil engineering programme. The established POs are aligned with the PEOs and are coherently linked to the university's mission and vision. Academic advisors often remind and brief students on PEOs, POs together with assessment methods at beginning of each semester. Course outcomes (COs) describe what students are expected to learn from an individual course (Hashim & Din, 2009). The course lecturer highlights the COs and learning outcomes (LOs), guiding the teaching and learning process for 14 weeks (Karman et al., 2011). Thus, OBE should have clarity of focus with clear intended outcomes, pitched at a high and challenging standard with differentiated strategies in teaching, learning and assessment (TLA) (Spady, 1994).

C. Teaching, Learning, Assessment (TLA) and Continual Quality Improvement (CQI)

While traditional teaching methods are teacher-centered and promote passive learning, the modern approach incorporates active learning strategies and technology integration (Biggs et al., 2022). Both face-to-face (F2F) and online teaching and learning methods show some effect on TLA. However, both forms of teaching share the same aspects in communication, collaboration, and interaction (Pérez et al., 2023). Adopting blended learning can combine the strengths of both F2F and online teaching and learning (Ripoll et al., 2021). In terms of assessments, there is a need to design comprehensive final-year engineering projects at the micro level based on their alignment with POs, addressing the challenge of mapping diverse projects through rubric-based evaluations (Karthikeyan et al., 2021). Chan (2012) reviewed various assessment methods used specifically for community service types of experiential learning to evaluate their appropriateness and found that while experiential learning is widely adopted in higher education, there is limited research on the assessment methods that align well with its learning outcomes. Hence, the course assessment tools can also be revised to suit the study environment. This ensures students motivation and achievement of learning outcomes in designated courses.

Continual quality improvement (CQI) is a cyclical process of self-reflection, data collection, analysis, and implementation of improvement strategies (Biggs et al., 2022). It is an essential part of the Outcome Based Education (OBE) approach, which requires continual review and measurement of programme educational objectives (PEOs) and programme outcomes (POs), corrective actions and continual improvement within a set time frame to ensure quality assurance (Abdullah et al., 2009; Mawandiya et al., 2022).

The improvement of the effectiveness and efficiency of TLA by developing a feedback loop from the stakeholders will regulate the continuous enhancement of the curriculum (Hattie & Timperley, 2007; Misran et al., 2011; W. Harlen, 2007). The OBE approach ensures that in every course, the curriculum is designed to prepare graduates for the workforce by equipping them with both technical skills and soft skills, including communication and leadership skills essential for their jobs.

In this paper, the EIS course has two (2) COs that must be attained and fulfilled through effective assessments, while the POs mapped to each CO respectively, are PO6 (Engineers and Society) and PO8 (Ethics & Professional Conducts). PO6 applies reasoning to assess societal, health, safety, legal and cultural issues, along with consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. PO8, on the other hand, focuses on applying ethical principles and commitment to professional ethics and responsibilities and norms of engineering practice. The assessment tools applied in the course give an indication of the achievement of POs and guide in determining the appropriate improvement of the teaching method (Osman et al., 2012).

The following section outlines the methodology adopted in this study, covering the research design, namely the mixed methods, a combination of qualitative and quantitative approaches.

3. Methodology

A. Research Design

This study utilized a mixed-method research design, combining quantitative and qualitative approaches. By employing this research design, the study aimed to gather comprehensive data from multiple cohorts of students (graduating in October 2019 to October 2022 semesters), combining quantitative and qualitative analysis as shown in Fig. 1. This approach provided a more comprehensive understanding of quality improvements in teaching, learning, and assessment in the Engineers in Society (EIS) course.

There were two (2) methods employed in this study: A longitudinal study (Oct 2019 – Oct 2022 semesters) and a student feedback survey. The longitudinal study analyzed student performance for two (2) programme outcomes which are PO6 (Engineers and Society) and PO8 (Ethics & Professional Conducts) based on direct continuous assessment using various tools namely, interim report, final report, video montage and presentation, together with the evaluation of the suggestions given by instructors at the end of the semester to improve the assessment tools for the course. The second method was a questionnaire survey designed to get feedback from the students on the TLA used for the course.

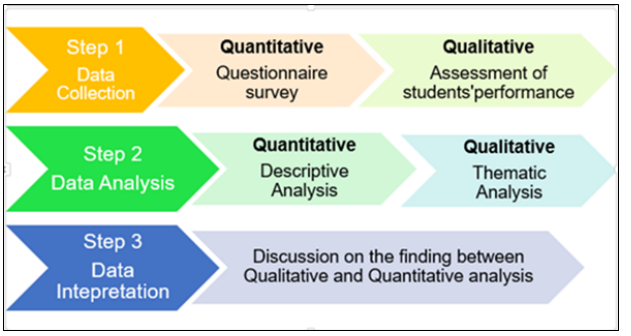


Fig. 1 : Flow of Methodology

A detailed description of the selection and nature of documents analyzed under the qualitative approach is presented in the next subsection.

B. Qualitative approach – Document Review

A longitudinal method was used to collect data from the same EIS course over an extended period of 7 semesters which were October 2019 (after curriculum review), March 2020 (during pandemic & introduction of SULAM), October 2020, March 2021, October 2021, March 2022, and October 2022 semesters.

During these periods, the assessment tools were changed from the examination based to project-based due to various factors such as covid-19 pandemic, the requirements by the Ministry of Higher Education Malaysia and University and based on continual quality improvement aspects.

1) Programme outcome data from myCOPO system

The first data collection focused on the students' direct programme outcome attainment of PO6 and PO8 based on various assessment tools that were

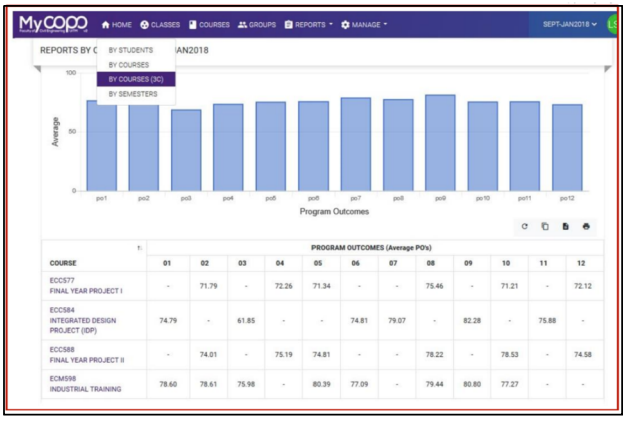


Fig. 2 : Twelve (12) Programme Outcomes Attainment From The Mycopo System.

obtained to study the students' performance throughout the 6 cycles. The data was extracted from an OBE assessment system known as myCOPO. Fig. 2 shows a snapshot of twelve (12) programme outcomes attainment from the system.

2) Criteria for evaluating programme outcomes.

During the October 2019 semester (before Covid19 pandemic), the evaluation of the programme outcomes was carried out through tests, assignment, and final examination. In March 2020 (during covid-19 pandemic) the assessments were based on tests and group projects. Starting October 2020, alternative assessment was adopted where four (4) continuous assessments were used namely, interim report, final report, video montage and presentation.

An instructional guidance was created by the instructors to assist the students to carry out their community projects more systematically and effectively. (see Fig. 3).

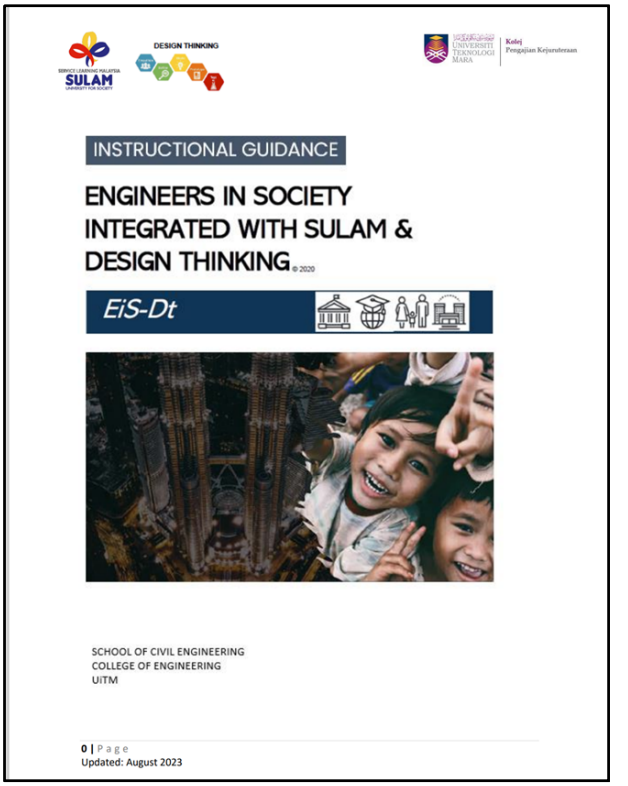
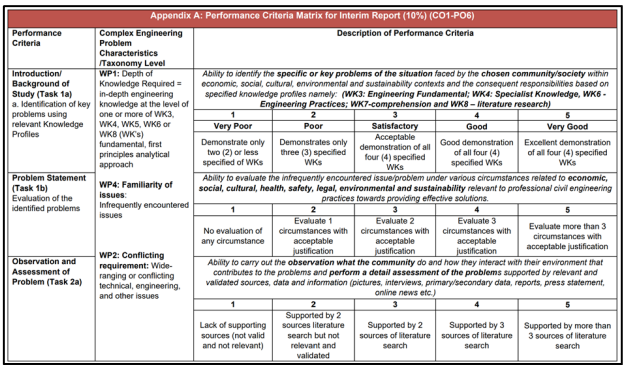


Fig. 3 : Instructional Guidance (2023) (MARA, 2023)

The guidance document consists of the Course Synopsis, Introduction to SULAM through Integrated Society Project (ISP), Course Outcomes (CO), Programme Outcomes (PO) and Complex Engineering Problems (WP), and Knowledge Profiles

(WK), Learning Outcomes, Specific Tasks, DT Process, Consideration of Sustainable Development Goals (SDGs), Generative Artificial Intelligence (AI) Application, Assessment, Advisor (Faculty Experts), Format of Report and Performance Criteria Matrix for each tool.

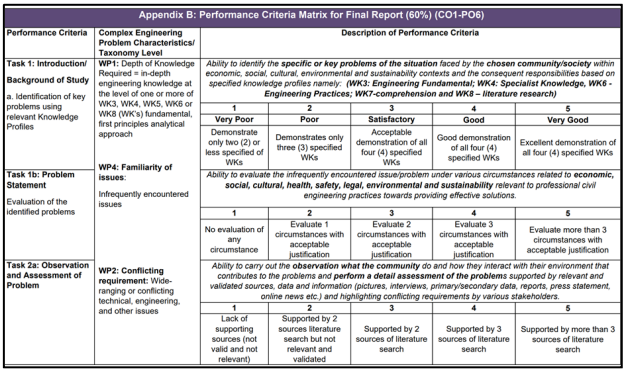
Thus, assessment rubrics or performance criteria matrix was further established for each tool. Assessment for PO6 is based on the interim report and final report while video montage and presentation



Appendix A: Performance Criteria Matrix for Interim Report (10%) (CO1-PO6)

Performance Criteria	Complex Engineering Problem Characteristics /Taxonomy Level	Description of Performance Criteria				
Introduction/ Background of Study (Task 1a) a. Identification of key problems using relevant Knowledge Profiles	**WP1:** Depth of Knowledge Required = in-depth engineering knowledge at the level of one or more of WK3, WK4, WK5, WK6 or WK8 (WK's) fundamental, first principles analytical approach	*Ability to identify the **specific or key problems of the situation** faced by the **chosen community/society** within economic, social, cultural, environmental and sustainability contexts and the consequent responsibilities based on specified knowledge profiles namely: **(WK3: Engineering Fundamental; WK4: Specialist Knowledge, WK6 - Engineering Practices; WK7-comprehension and WK8 – literature research)***				
		1	2	3	4	5
		Very Poor	**Poor**	**Satisfactory**	**Good**	**Very Good**
		Demonstrate only two (2) or less specified of WKs	Demonstrates only three (3) specified WKs	Acceptable demonstration of all four (4) specified WKs	Good demonstration of all four (4) specified WKs	Excellent demonstration of all four (4) specified WKs
Problem Statement (Task 1b) Evaluation of the identified problems	**WP4: Familiarity of issues**: Infrequently encountered issues	*Ability to evaluate the infrequently encountered issue/problem under various circumstances related to **economic, social, cultural, health, safety, legal, environmental and sustainability** relevant to professional civil engineering practices towards providing effective solutions.*				
		1	2	3	4	5
		No evaluation of any circumstance	Evaluate 1 circumstances with acceptable justification	Evaluate 2 circumstances with acceptable justification	Evaluate 3 circumstances with acceptable justification	Evaluate more than 3 circumstances with acceptable justification
Observation and Assessment of Problem (Task 2a)	**WP2: Conflicting requirement:** Wide-ranging or conflicting technical, engineering, and other issues	*Ability to carry out the **observation what the community** do and how they interact with their environment that contributes to the problems and **perform a detail assessment of the problems** supported by relevant and validated sources, data and information (pictures, interviews, primary/secondary data, reports, press statement, online news etc.)*				
		1	2	3	4	5
		Lack of supporting sources (not valid and not relevant)	Supported by 2 sources literature search but not relevant and validated	Supported by 2 sources of literature search	Supported by 3 sources of literature search	Supported by more than 3 sources of literature search

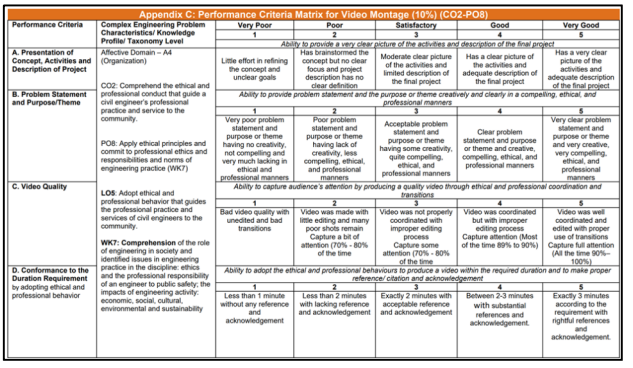
Fig. 4 : Excerpt from Interim Report Performance Criteria Matrix



Appendix B: Performance Criteria Matrix for Final Report (60%) (CO1-PO6)

Performance Criteria	Complex Engineering Problem Characteristics/ Taxonomy Level	Description of Performance Criteria				
Task 1: Introduction/ Background of Study a. Identification of key problems using relevant Knowledge Profiles	**WP1:** Depth of Knowledge Required = in-depth engineering knowledge at the level of one or more of WK3, WK4, WK5, WK6 or WK8 (WK's) fundamental, first principles analytical approach	*Ability to identify the **specific or key problems of the situation** faced by the **chosen community/society** within economic, social, cultural, environmental and sustainability contexts and the consequent responsibilities based on specified knowledge profiles namely: **(WK3: Engineering Fundamental; WK4: Specialist Knowledge, WK6 - Engineering Practices; WK7-comprehension and WK8 – literature research)***				
		1	2	3	4	5
		Very Poor	**Poor**	**Satisfactory**	**Good**	**Very Good**
		Demonstrate only two (2) or less specified of WKs	Demonstrates only three (3) specified WKs	Acceptable demonstration of all four (4) specified WKs	Good demonstration of all four (4) specified WKs	Excellent demonstration of all four (4) specified WKs
Task 1b: Problem Statement Evaluation of the identified problems	**WP4: Familiarity of issues**: Infrequently encountered issues	*Ability to evaluate the infrequently encountered issue/problem under various circumstances related to **economic, social, cultural, health, safety, legal, environmental and sustainability** relevant to professional civil engineering practices towards providing effective solutions.*				
		1	2	3	4	5
		No evaluation of any circumstance	Evaluate 1 circumstances with acceptable justification	Evaluate 2 circumstances with acceptable justification	Evaluate 3 circumstances with acceptable justification	Evaluate more than 3 circumstances with acceptable justification
Task 2a: Observation and Assessment of Problem	**WP2: Conflicting requirement:** Wide-ranging or conflicting technical, engineering, and other issues	*Ability to carry out the **observation what the community** do and how they interact with their environment that contributes to the problems and **perform a detail assessment of the problems** supported by relevant and validated sources, data and information (pictures, interviews, primary/secondary data, reports, press statement, online news etc.) and highlighting conflicting requirements by various stakeholders.*				
		1	2	3	4	5
		Lack of supporting sources (not valid and not relevant)	Supported by 2 sources literature search but not relevant and validated	Supported by 2 sources of literature search	Supported by 3 sources of literature search	Supported by more than 3 sources of literature search

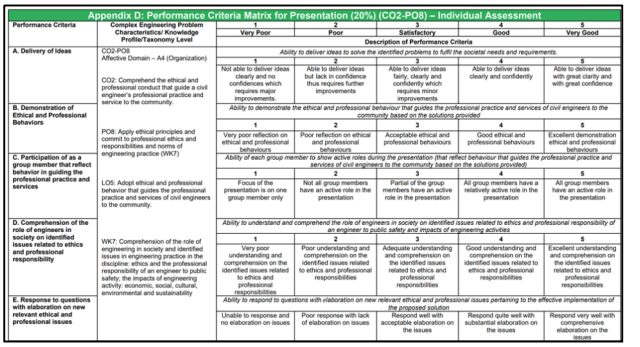
Fig. 5 : Excerpt from Final Report Performance Criteria Matrix Report



Appendix C: Performance Criteria Matrix for Video Montage (10%) (CO2-PO8)

Performance Criteria	Complex Engineering Problem Characteristics/ Knowledge Profile/ Taxonomy Level	Very Poor	Poor	Satisfactory	Good	Very Good
		1	2	3	4	5
A. Presentation of Concept, Activities and Description of Project	Affective Domain – A4 (Organization)	*Ability to provide a very clear picture of the activities and description of the final project*				
		Little effort in refining the concept and unclear goals	Has brainstormed the concept but no clear focus and project description has no clear definition	Moderate clear picture of the activities and limited description of the final project	Has a clear picture of the activities and adequate description of the final project	Has a very clear picture of the activities and adequate description of the final project
B. Problem Statement and Purpose/Theme	CO2: Comprehend the ethical and professional conduct that guide a civil engineer's professional practice and service to the community.	*Ability to provide problem statement and the purpose or theme creatively and clearly in a compelling, ethical, and professional manners*				
		1	2	3	4	5
	PO8: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice (WK7)	Very poor problem statement and purpose or theme having no creativity, not compelling and very much lacking in ethical and professional manners	Poor problem statement and purpose or theme having lack of creativity, less compelling, ethical, and professional manners	Acceptable problem statement and purpose or theme having some creativity, quite compelling, ethical, and professional manners	Clear problem statement and purpose or theme and creative, compelling, ethical, and professional manners	Very clear problem statement and purpose or theme and very creative, very compelling, ethical, and professional manners
C. Video Quality	**LO5**: Adopt ethical and professional behavior that guides the professional practice and services of civil engineers to the community.	*Ability to capture audience's attention by producing a quality video through ethical and professional coordination and transitions*				
		1	2	3	4	5
	WK7: Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability	Bad video quality with unedited and bad transitions	Video was made with little editing and many poor shots remain Capture a bit of attention (70% - 80% of the time	Video was not properly coordinated with improper editing process Capture some attention (70% - 80% of the time	Video was coordinated but with improper editing process Capture attention (Most of the time 89% to 90%)	Video was well coordinated and edited with proper use of transitions Capture full attention (All the time 90%– 100%)
D. Conformance to the Duration Requirement by adopting ethical and professional behavior		*Ability to adopt the ethical and professional behaviours to produce a video within the required duration and to make proper reference/ citation and acknowledgement*				
		1	2	3	4	5
		Less than 1 minute without any reference and acknowledgement	Less than 2 minutes with lacking reference and acknowledgement	Exactly 2 minutes with acceptable reference and acknowledgement	Between 2-3 minutes with substantial references and acknowledgement.	Exactly 3 minutes according to the requirement with rightful references and acknowledgement.

Fig. 6 : Excerpt from Video Montage Performance Criteria Matrix



Appendix D: Performance Criteria Matrix for Presentation (20%) (CO2-PO8) – Individual Assessment

Performance Criteria	Complex Engineering Problem Characteristics/ Knowledge Profile/Taxonomy Level	1 Very Poor	2 Poor	3 Satisfactory	4 Good	5 Very Good
		Description of Performance Criteria				
A. Delivery of Ideas	CO2-PO8 Affective Domain – A4 (Organization)	*Ability to deliver ideas to solve the identified problems to fulfil the societal needs and requirements.*				
		1	2	3	4	5
	CO2: Comprehend the ethical and professional conduct that guide a civil engineer's professional practice and service to the community.	Not able to deliver ideas clearly and no confidences which requires major improvements.	Able to deliver ideas but lack in confidence thus requires further improvements	Able to deliver ideas fairly, clearly and confidently which requires minor improvements	Able to deliver ideas clearly and confidently	Able to deliver ideas with great clarity and with great confidence
B. Demonstration of Ethical and Professional Behaviors		*Ability to demonstrate the ethical and professional behaviour that guides the professional practice and services of civil engineers to the community based on the solutions provided*				
		1	2	3	4	5
	PO8: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice (WK7)	Very poor reflection on ethical and professional behaviours	Poor reflection on ethical and professional behaviours	Acceptable ethical and professional behaviours	Good ethical and professional behaviours	Excellent demonstration ethical and professional behaviours
C. Participation of as a group member that reflect behavior in guiding the professional practice and services		*Ability of each group member to show active roles during the presentation (that reflect behaviour that guides the professional practice and services of civil engineers to the community based on the solutions provided)*				
		1	2	3	4	5
	LO5: Adopt ethical and professional behavior that guides the professional practice and services of civil engineers to the community.	Focus of the presentation is on one group member only	Not all group members have an active role in the presentation	Partial of the group members have an active role in the presentation	All group members have a relatively active role in the presentation	All group members have an active role in the presentation
D. Comprehension of the role of engineers in society on identified issues related to ethics and professional responsibility		*Ability to understand and comprehend the role of engineers in society on identified issues related to ethics and professional responsibility of an engineer to public safety and impacts of engineering activities*				
		1	2	3	4	5
	WK7: Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability	Very poor understanding and comprehension on the identified issues related to ethics and professional responsibilities	Poor understanding and comprehension on the identified issues related to ethics and professional responsibilities	Adequate understanding and comprehension on the identified issues related to ethics and professional responsibilities	Good understanding and comprehension on the identified issues related to ethics and professional responsibilities	Excellent understanding and comprehension on the identified issues related to ethics and professional responsibilities
E. Response to questions with elaboration on new relevant ethical and professional issues		*Ability to respond to questions with elaboration on new relevant ethical and professional issues pertaining to the effective implementation of the proposed solution*				
		Unable to response and no elaboration on issues	Poor response with lack of elaboration on issues	Respond well with acceptable elaboration on the issues	Respond quite well with substantial elaboration on the issues	Respond very well with comprehensive elaboration on the issues

Fig. 7 : Excerpt from Presentation Performance Criteria Matrix

assess PO8. Each tool incorporates specific performance criteria to ensure direct assessment related to the programme outcomes. Excerpts of performance criteria matrix for each assessment tool are presented in Figures 4 to 7.

3) CQI actions proposed by instructors at the end of semester

The CQI actions provided by the instructors at the end of the semester within the same course over time were also evaluated to study the effectiveness of the assessment. The CQI actions provided are open-ended statements focusing on the specific course and programme outcome. An example of a CQI template with CQI action can be seen on Fig. 8.

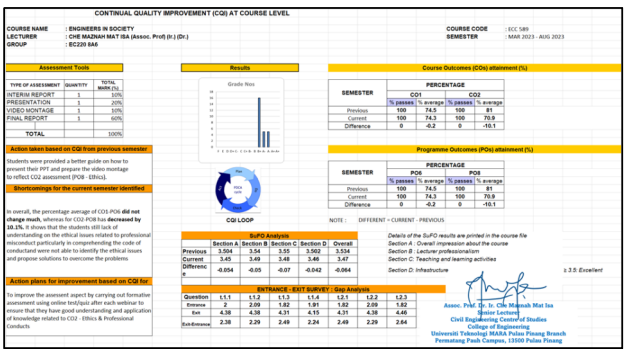


Fig. 8 : Sample of CQI Template with Suggestions for Improvements on Assessment

Moreover, the CQI suggestions and actions are also analyzed using thematic analysis to identify common themes or patterns in the instructors' recommendations for improvement. The thematic analysis was based on the students' performance contributed by the programme outcome attainment which mapped to PO6 and PO8 using the direct measurement in the EIS course. The analysis from this study covers the developmental patterns, tracking changes, and analyzing the cause-effect relationships

that unfold over time. Overall, this qualitative analysis provided valuable insights into the specific areas where improvement is needed and informed future instructional strategies or changes to the course design and assessment.

C. Quantitative Approach

A quantitative approach was also utilized as an indirect measurement by employing a questionnaire survey administered using Google Forms and distributed via WhatsApp. The study involved a total of 462 Civil Engineering students at Universiti Teknologi MARA, Malaysia who had taken the Engineers and Society (EIS) course at multiple time points, including October 2019 (after curriculum review), March 2020 (during the COVID-19 pandemic), October 2020, March 2021, October 2021, March 2022, and October 2022. A purposive sampling technique was employed to select participants who had completed the EIS course. The sample included students from different batches and cohorts to ensure representation across different semesters and academic years. This approach aimed to capture a diverse range of experiences and perspectives. Each respondent was allowed to submit only one response.

The survey instrument for this study was designed based on important key criteria to ensure comprehensive and relevant data collection aligned with the objectives of the study which include, (1) the students' background, (2) the content validity of the survey which was established through expert reviews who were the resource person and lecturers responsible for the course, (3) to ensure consistency in the results, the survey was piloted with a small group of students from a similar course. Adjustments were made based on feedback to enhance clarity and reduce ambiguity, thereby increasing the reliability of the responses, (4) questions were designed to elicit insights into the effectiveness of the assessment tools used, the challenges that the students faced in the course and the recommendations to improve the course.

Based on these criteria, the survey instrument was structured into five (5) sections to provide valuable insights into the effectiveness of the implementation of the EIS course and support continual improvements in teaching, learning and assessment methodologies. The sections are Section A: Demographic Background, Section B: Perception and Understanding of SULAM Approach (Likert scale), Section C: Effectiveness of Assessment Tools (Likert scale), Section D: Challenges Faced by Respondents (Likert Scale) and Section E: Recommendations and Improvements (chosen by the respondents based on given statement). This paper presents the results from Section C and Section E only. In addition, a reliability test was carried out on the instrument, resulting in a Cronbach's alpha of 0.711 for Section C on the effectiveness of assessment tools used. Then, the descriptive analysis such as percentage value was performed to analyze the data obtained through the questionnaire survey.

4. Analysis

This section presents the quantitative analysis of the survey data (Section A, Section B, C and E). The questionnaire was distributed to 462 students who had taken the EIS course, with a response rate of 36%. Based on Section A, most respondents were between the ages of 24 and 26, almost all had taken the EIS course, and nearly half had a cumulative grade point average (CGPA) of 3.0 or higher.

A. Analysis on Respondents' Feedback on the Effectiveness of the Assessment Tools used in the EIS Course for Section B, C, and E

Based on Section B, the survey results indicate that 80% of students are aware of the establishment of SULAM by the Ministry of Education (MoE) Malaysia and consider it an effective initiative for realizing the aspirations of the MoE. These findings highlight the crucial role of SULAM in achieving the educational goals set by the government. Almost all the surveyed students have a clear understanding of the purpose of SULAM. This indicates that a vast majority of students recognize the role of universities in society and the importance of preparing students to become responsible public intellectuals capable of addressing society's challenges. The results provide an insight into the experiences of a subset of the target population, despite the low response rate.

Fig. 9 shows the analysis results of Section C, the respondents' feedback on the effectiveness of the assessment tools used in the EIS course. The data shows that most students (98%) found the presentation, interim and final reports, and video montage to be effective assessment tools. Presentation is the most effective assessment tool, while the other three tools received favorable ratings as well. This

might be due to the advantages of presentations, such as faster preparation, group support, effective communication and immediate feedback from lecturers. Students express their learning experiences, clarify missing elements in the reports, interact actively with their lecturer and receive feedback for further improvement through the presentation. This suggests that these tools can be reliable indicators of students' progress throughout the course. Overall, the results indicate that the four assessment tools used in the EIS course are effective.

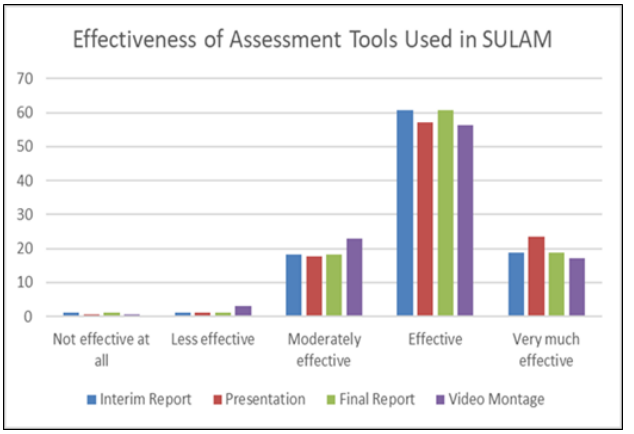


Fig. 9 : Effectiveness of Assessment Tools

B. Suggestions for Improvement by the Respondents

Based on Section E, the students provided five (5) top recommendations for improvement with the highest percentage (23%) indicating a need for financial support from the university, potentially due to the impact of the COVID-19 outbreak on their finances. The second highest recommendation (18%) is on improvement to the assessment tools used, suggesting that students may feel that the current assessment methods could be more effective or fairer. The students felt they deserved higher grades after completing a complex project that deals with stakeholders, a time-consuming and long administration process. The explicitness of the rubrics detailed on the scopes and expected outcomes could be revisited. Facilities such as the internet and conducive environment also received a significant percentage (16%) of recommendations, indicating that students may feel that these factors could be improved to enhance their learning experience.

Facility improvements, particularly better Wi-Fi coverage and connectivity, and conducive meeting rooms for brainstorming and discussion are expected. Improvement in support from lecturers/advisors (15%) was also recommended, highlighting the importance of quality guidance and mentorship for student success.

The syllabus and teaching delivery method received the fewest recommendations (14%), indicating that most students were satisfied with the current course material and teaching approach.

Overall, the findings suggest that students provided diverse and relevant recommendations for improvement, and the programme should consider implementing these suggestions to enhance the learning experience for students.

The following sections present two (2) parts of the analysis: (1) analysis of students' performance and (2) evaluation of the CQI actions suggested and closed by the instructors based on document review.

5. Results Analysis From The Direct Assessment

A. Direct Attainment of Programme Outcomes based on Assessment Tools Used

This section presents an analysis of student performance based on their direct attainment of programme outcomes for PO6 and PO8. The data was extracted from an assessment system developed by the programme, known as the myCOPO system for seven (7) semesters (October 2019, March 2020, October 2020, March 2021, October 2021, March 2022, and October 2022). This study examines

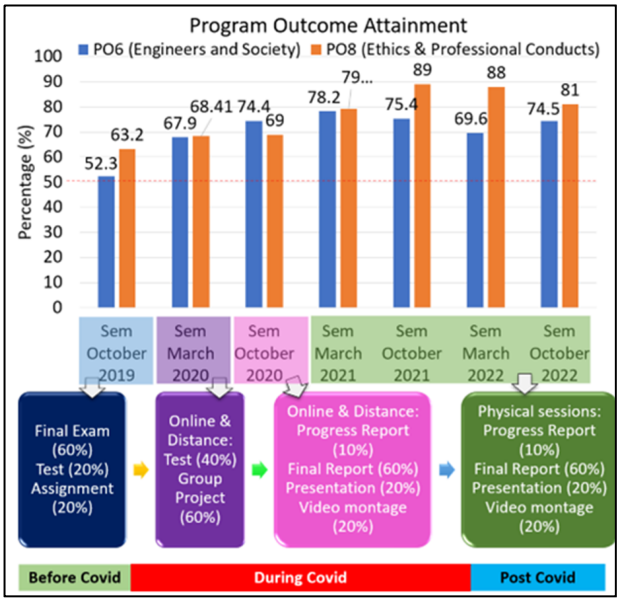


Fig. 10 : PO6 and PO8 Attainment

student programme attainment, focusing on the evaluation through different assessment tools before, during and after the post COVID-19 pandemic.

In Fig. 10, the data illustrates the attainment levels for PO6 and PO8 across seven semesters, spanning from October 2019 to October 2022.

Prior to the COVID-19 pandemic, the assessment tools used were final examination (60%), test (20%), and assignment (20%). During the pandemic, for Semester March 2020, the assessment tools changed to online test (40%) and group project (60%). Later, starting from Semester October 2020, four (4) different continuous assessments namely, Progress Report (10%), Final Report (60%), Video Montage (10%) and Presentation (20%) were introduced. These assessments were retained after the COVID-19 pandemic when the physical session resumed, contributing to PO6 and PO8.

By referring to Fig.10, based on the performance of both programme outcomes, the findings show that these attainment levels consistently exceed the established passing threshold of 50% and show an overall upward trend in PO6 and PO8 attainment for the past three years. Examining the trend for PO6, there is an improvement from Semester October 2019 (52.3%) to Semester March 2021 (78.3%). However, there is a slight decrease in performance in Semester March 2022 (69.6%) compared to the previous semester. The performance then improves again in Semester October 2022 (74.5%). PO8 also demonstrates consistent improvement over the past seven semesters. Performance increases from 63.2% in Semester October 2019 to 68.44% in Semester March 2020. There is a slight decrease in performance in Semester October 2020 (69%), but the performance improves significantly in Semester March 2021 (80.3%). The performance then continues to improve in Semester October 2021 (88.8%), and although there is a slight decrease in performance in Semester March 2022 (88.6%), the performance is still higher compared to the previous semesters. In Semester October 2022, there was a slight decrease in performance (81.0%) compared to the previous semester. Overall, the trend for PO8 shows consistent improvement over the past seven (7) semesters.

The enhancement of student attainments in PO6 and PO8 over the past three years can be primarily attributed to a strategic shift in assessment methodologies, transitioning from traditional final examinations and tests to a greater emphasis on reports and presentations. Moreover, the positive impact on student attainments is further supported by shifts in the mode of delivery and assessments, with particular emphasis on physical sessions. In alignment with student preferences for assessments like presentations, the sharing of service activities through professional practices within the community has proven to be more enjoyable and effective, as highlighted by student feedback (refer to Fig. 9). Given that the anticipated service-learning outcomes in the course lean towards affective learning domains, assessments reliant on cognitive-type evaluations, such as final exams and tests, may inadequately capture the behavioral attitudes of students towards societal contribution and ethical conduct. In this context, reports and presentations emerge as more effective assessment tools, facilitating a direct evaluation of student achievements in meeting the objectives outlined in PO6 and PO8 within the course, EIS.

Next section focuses on the analysis of CQI actions extracted from the document review of the course file for the course.

6. Continual Quality Improvement And Closing Of The Loop Based On Document Analysis

This section presents the CQI actions which are aligned to the six (6) cycles within seven (7) semesters in closing of the loop starting March 2019 to October 2022 semesters.

A. October 2019 Semester

Prior to COVID-19 pandemic, the assessment tools used in the October 2019 Semester were based on final examination (60%), test (20%) and assignment (20%) reflected mostly on the individual assessments. The PO6 and PO8 attainments were 52.3% and 63.2%, respectively. The CQI actions proposed were to improve on the building of knowledge for the students to better understand and apply the knowledge related to engineering practices as engineers and awareness of the ethical and professional conducts as future engineers.

B. March 2020 Semester

In the March 2020 Semester, due to the COVID-19 pandemic, a new set of continuous assessment was introduced namely test (40%) and group project

(60%). In addition, SULAM project was introduced as a new teaching and learning pedagogy. However, considering the movement restriction operation enforced by the government, quality of the online learning strategies, facilities, and internet connectivity at home, and maintaining students' mental health were important elements. Instead of the engagement with a variety of stakeholders in the group projects, students were only required to propose conceptual innovative engineering solutions. In terms of closing the loop to address the previous recommendations, the changes that took place were innovative learning strategies, home facilities and internet connectivity for online classes. The students were not allowed to be engaged directly with the stakeholders due to the restrictions by the university and government.

The analysis of results revealed improvements in both PO6 and PO8, with PO6 increasing from 52.3% to 67.9% and PO8 improving from 63.2% to 68.41%. It was evident that the sudden shift from face-to-face learning to online learning, along with changes in project requirements, appeared to benefit student learning performance. This is reflected in those results on better students' performance scores which could be associated with the enhanced time management efficiency (Pérez et al., 2023).

Overall, the results demonstrate a normal distribution of grades as shown in Fig. 11.

Even though the normal distribution is observed, there is still room for improvement in the ethical aspects of the course content, and CQI action plans for the current semester involve incorporating more case studies related to ethics and professional conduct in the project requirements. To ensure that students focus more on these aspects, ethical requirements should be included in the project rubrics. Since group projects comprise a larger portion of the assessment, a dedicated project advisor is recommended to guide each group in achieving the intended outcomes.

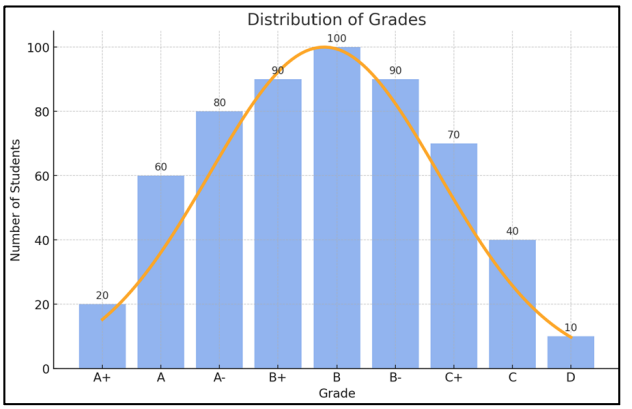


Fig. 11 : Distribution of Grades by Students for March 2020 Semester

In addition, the enhancement of instructional materials for problem solving in engineering projects may potentially contribute to the ability of the engineering graduates to solve complex problems (Liew et al., 2020) . Thus, providing detailed rubrics with clear criteria for assessment would help students understand how they will be evaluated by the lecturer.

The abrupt transition from physical to online and distance learning has disrupted the experiential aspect of service learning, substituting it with merely submitting proposals and confirming understanding of the course contents through individual written tests. Although students actively engage in identifying community problems and brainstorming professional solutions, they express a lack of appreciation for the experience's authenticity compared to real practice of community project. The absence of a systematic online approach of SULAM in the course necessitates CQI. Consequently, there is a pressing need to prioritize the establishment of guidance and methodologies to enhance student engagement with the community virtually in the upcoming semester.

C. October 2020 Semester

In the October 2020 semester, physical engagement with the community and industry collaborator was further disrupted due to the increased cases in COVID-19. To adapt to the situation, most students chose to conduct their community projects virtually with the advisors' assistance. While the industry collaboration showed good commitment, there were still some groups that lacked interaction with the community. Assessment improvement was further carried out on a new set of assessment tools used: progress report (10%), final report (60%), presentation (20%), and video montage (20%). Rubrics for all four assessment tools were also developed.

Even though the results improved, the distribution of grades did not show a normal distribution and skewed towards A grades, as shown in Fig. 12. This may be due to the group work assessment accounting for more than 80% of the overall marks, with only a smaller percentage allocated for individual

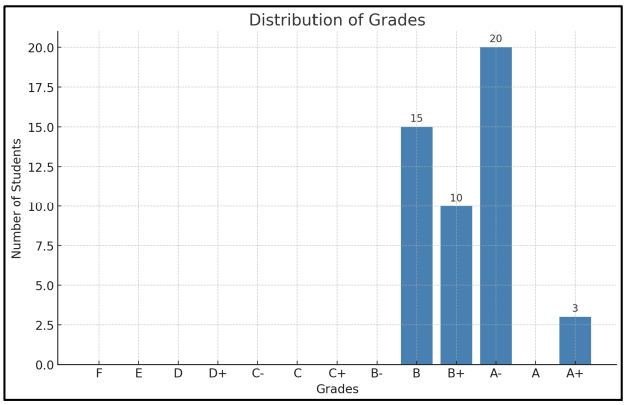


Fig. 12: Distribution of Grade by Students for October 2020 Semester

assessment based on the presentation (20%). To continue improving, the initiative with the current stakeholders, including industry and community, can be carried forward to next semester. In addition, ethical issues, and solutions to overcome professional misconduct (PO8) should be clearly explained to students so they can apply it to their projects.

There are groups of stakeholders involved in the implementation of service-learning projects who are usually the communities or companies that would benefit directly from service-learning projects. It was found that some students encountered challenges where some companies refuse to give their cooperation in addition to the lack of community cooperation (Yusof et al., 2020).

Thus, the networking and collaboration with the external stakeholders, namely industry and community, will be improved. The course assessment tools will also be reviewed to have a higher percentage of individual assessment, with 30% being allocated for individual assessment which are the individual weekly progress contributing to the group project (10%), individual proposed solutions towards solving community problems (20%).

Regarding programme outcome performance, there was a slight decrease in PO8 attainment during the October 2020 semester (69%). However, PO6 showed significant improvement.

D. March 2021 Semester

In the March 2021 semester, students have been engaging with the community physically. The revised assessment tools and rubrics with a higher percentage of individual assessment on the project submitted reflected a successful closing of the loop at the course level, led to a significant improvement in PO6 attainment from 74.4% to 78.2% and PO8 attainment from 69% to 79.3%.

It is worth noting that all students passed both programme outcomes. However, despite these improvements, the distribution of grades did not indicate a normal distribution and skewed towards A grade. To address this issue, it may be necessary to revisit the assessment tools, rubrics, and roles of the assessor to ensure a more balanced distribution of grades in the future.

E. October 2021 Semester

In the October 2021 semester, the course assessment tools were revised based on the previous semester's CQI recommendations. However, the results of the current semester indicate a slight decrease in PO6 attainment from 78.2% to 75.4%, while PO8 attainment improved significantly from 79.3% to 89%. It is worth noting that all students passed both POs. Like the previous semester, although some improvements were made such as briefing to students and assessors on the assessment criteria and rubrics descriptors, and effort to increase the consistency in marking among assessors, the distribution of grades remains skewed towards A, indicating the need for further improvements in the rubrics to ensure accurate measurement based on the design thinking systematic steps. This issue was considered in next semester's CQI plan.

F. March 2022 Semester

The analysis of the March 2022 Semester results indicates a significant decrease in PO6 attainment, which dropped from 75.4% in the previous semester to 69.6%, while PO8 attainment remained relatively stable at 88%. To address the decline in PO6, it is necessary to improve the assessment tools to focus specifically on certain criteria and re-evaluate the rubrics for both presentation and video montage in the upcoming semester. The community is chosen by the students as a case study. The case-based assessment needs to be guided through more regularly in each task given (Kamardeen, 2014). Case studies and presentations of real-world problems provide students with the opportunity to independently understand and analyse practical challenges, apply their knowledge and skills to develop solutions, and effectively communicate their solutions (Nallakukkala et al., 2018). Therefore, an instructional guide has been

designed to provide students with better guidance on how to conduct their community projects.

G. October 2022 Semester

In the October 2022 semester, there was an improvement in PO6 attainment from 69.6% to 74.5%. However, there was a significant decrease in PO8 attainment from 88.6% to 81.0%. This decrease may be attributed to the assessment tools of presentation and video montage, where the content did not sufficiently reflect the ethical components required for PO8 assessment. The power point presentations may efficiently build a student's background knowledge of the material properties, historical background, and contemporary applications by pooling the research efforts of the group (Renard, 2014). To address this issue, a CQI action plan was implemented to provide better guidance and advice to students on how to improve their power point presentation and video montage to better reflect PO8 (Ethics) assessment criteria.

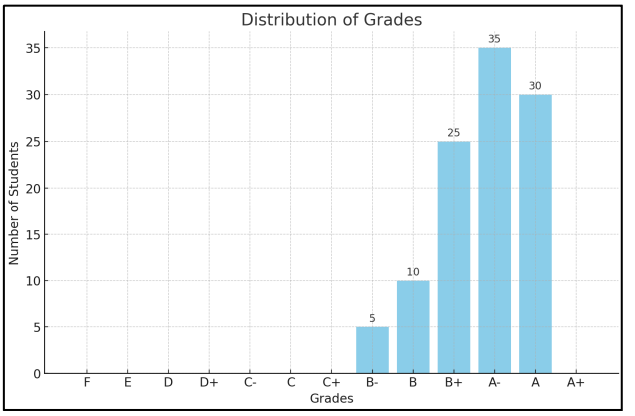


Fig. 13 : Distribution of Grade by Students for October 2022 Semester

The student attainment average for PO6 and PO8, hovering around 75%, has manifested in a grade distribution skewed towards the A grade, as depicted in Fig. 13.

The semester's student attainment is commendable, primarily owing to the strong support extended by the institutions for community projects. It was observed that the application procedures for student activities have become more transparent and user-friendly over successive semesters with the incorporation of physical delivery sessions.

Furthermore, the initiatives by students are now more warmly embraced within the community, with fewer restrictions on social interactions due to the easing impact of the COVID-19 pandemic. This favorable reception has contributed significantly to the positive atmosphere surrounding student activities in the community and has likely motivated students to deliver a more successful community project.

The following section presents the discussion based on the consolidated findings from both qualitative and quantitative analyses.

H. Discussion and Consolidation of Findings

The findings highlight the importance of continual quality improvement (CQI) in teaching, learning, and assessment (TLA) to ensure that students receive the best possible education and achieve the intended learning outcomes. The need for improvements in assessment tools is very important as highlighted by the students in their recommendations for improvements in assessment tools. The skewed distribution of grades towards "A" suggests that there is a need for further refinement of the rubrics to ensure accurate measurement of student performance, especially on the individual judgment, problem solution skills, and ethical behavior.

Components of reflection, its assessment methods, and its effects on students engaged in service-learning experiences were studied by (Bowen, 2010). Their findings shed light on the valuable role and impact of meaning making through reflection within the context of courses. Therefore, introducing other learning methods, such as reflection, in the course can be considered. The importance of support from lecturers/advisors for quality guidance and mentorship for student success is also emphasized in the students' recommendations as highlighted in the UNESCO report (UNESCO, 2021). The community project implementation was also studied by the government, the university, and the school to provide instructional guidance to assist the students on how to carry out their community projects effectively. Starting from the semester of March 2023, more internal and external grants to support the student community project were initiated. With such incentives, the students can plan for a more impactful and meaningful learning experience with the local and international communities.

The content of the syllabus and teaching delivery method is also essential to ensure that students are satisfied with the course material and teaching

approach. Continuous review and improvement of the course content and teaching approach is necessary to ensure that students receive the best possible education.

Conclusion

This study covers continual improvement aspects related to teaching, learning, and assessment (TLA). Students' recommendations from the survey include improvements in assessment tools, facilities, lecturer/advisor support, and syllabus content and teaching delivery method highlight the importance of ensuring that the learning environment is conducive to student success.

The document reviews highlighted improvement in assessment tools to assess specific criteria and refining rubrics to ensure accurate measurement of student performance. Reports and presentations are more effective in gauging students' achievements in service learning, specifically concerning responsibilities associated with professional engineering practices within society and professional ethics, as opposed to final examinations and tests. The implementation of several continual quality improvement (CQI) strategies to tackle the challenges of online and distance-mode service learning, such as providing effective guidance on virtual collaborations and employing suitable assessment tools, significantly enhances student attainment. Providing instructional guidance to students is essential to equip them with the necessary skills to successfully carry out community projects.

Overall, the study provides valuable insights into the challenges and opportunities in the education system and emphasizes the importance of CQI to ensure that students are well-equipped to become responsible public intellectuals capable of addressing society's challenges.

Limitations Of Study And Recommendations For Future Research

The following limitations suggest the need for further research to better understand the experiences of students and identify areas for improvement in teaching, learning, and assessment (TLA). First, this research is confined to a singular course, namely "Engineers in Society," focusing on two specific programme outcomes in civil engineering programme at a public institution of higher learning in Malaysia. Thus, the findings from this study may be context-specific, limiting their generalizability to other settings. Consequently, the outcomes of this study may not be fully representative of other courses, programmes, or institutions. Therefore, future research endeavors could explore the effectiveness of TLA methods across diverse courses, various programme outcomes within different engineering programmes, and across institutions. Next, this study involved a relatively small sample size, potentially impacting the statistical power of the analysis and thereby limiting the generalizability of the findings to a broader population. Future research initiatives could address this limitation by employing a larger sample size and incorporating a more diverse range of institutions and student populations. Finally, the current study primarily utilized descriptive statistics and did not engage inferential methods to examine the relationships between variables, thus the future studies should employ inferential statistical methods to analyze the relationships between variables in a more rigorous manner. This will enable researchers to draw conclusions about causality and the strength of associations, providing a deeper understanding of the dynamics within the data. By recognizing the broader implications of understanding the impact of service learning in terms of community empowerment and collaboration, the findings from service-learning research can contribute to the enhancement of academic curricula and educational frameworks.

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