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Evaluating the Influence and Modification for Environment and Sustainability Learning Outcome in Environmental Engineering Course During COVID-19 Pandemic*

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The pandemic has influenced most of us either directly or indirectly. In ensuring the education is always in line with the National Education Philosophy in developing holistic, entrepreneurial, and balanced graduates, the Civil Engineering Program of Universiti Malaysia Sabah utilizes the UMS-OBE system, particularly in course outcome (CO) input to the program outcomes (PO) in the assessment and reporting of student's performance. As the main stakeholders, learners and lecturers must be actively engaged in the rationale and motivation of implementing the OBE mechanisms. Hence this paper evaluated the course learning outcome and measured their perceptions by categorizing the ranked perception feedback on project-based learning (PBL). This paper highlights the modification in implementing PBL that previously involved physical work on-site. Due to the movement control order (MCO) enforced due to the covid-19 pandemic, the course assessment targeted to instill the program outcome (PO) of Environment and Sustainability attribute was strategized into 3 phases. The analysis found that the course outcome has been successfully achieved, even though a slight decrease was observed from the previous regular face-to-face mode. A slight decrease was observed in the overall grade achievement and course outcome analysis. The instructional modification and intervention in Project-Based-learning to improve online learning strategies, despite the requirement for engineering community fieldwork through the learner's feedback responses during the three phases in model strategies for course outcome pedagogy, have shown optimistic input by learners and has continuously engaged them through the Project-based-Learning completion.

Keywords: outcome-based assessment (OBE); engineering education; COVID-19 pandemic; Movement control order (MCO); fieldwork learning requirement; project-based learning (PBL)

1. Introduction

The urgent need to contain the COVID-19, a highly contagious virus, has undertaken the Malaysian government to enforce movement-control order (MCO). Although beneficial for public health importance, it has directly induced a massive disruption to daily life and socio-economic activities. Malaysia's Movement Control Order (MCO) was initially enforced on March 18, 2020, during the first wave, with the closure of educational institutions and all government and private premises except those involved in essential services. Then, in September 2020, MCO was implemented again, considering the rapid increase in COVID-19 or the second wave.

Almost a year, this pandemic still existed yet was controlled in Malaysia. Hence the Teaching and learning activities must be resumed. Malaysia Ministry of Higher Education announced that all teaching and learning (T&L) activities should be implemented online by December 31, 2020 [1]. Therefore, all face-to-face teaching and learning activities are not allowed. Higher learning institutions take various approaches to adapt to the current MCO, such as rearranging the semester timetable, shifting to online teaching activities, and developing standard operating procedures (SOPs) according to the National Security Council (MKN).

More flexible T&L techniques have resulted from the pandemic. Synchronous and asynchronous teaching modes and online assignment submissions have become a norm in university teaching today. However, the problem of online or remote education by students includes technical issues associated with the learning Apps variations, limited network issues, lack of interactions among learners, duration and schedule matters, distraction in a home environment, teaching and materials resources unavailability, and too many assignments/activities and screen time [2]. Other issues for instructors teaching online affect learners have induced various communication barriers, and instructors are concerned about time-consuming preparation, styles, and pedagogical roles [3, 4]. The course instructor must consider all concerns to enhance teaching and learning quality performance.

Malaysian Engineering education controlled by the Board of Engineers Malaysia (BEM) [5], has provided a guiding principle to ensure the Engineer-

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ing Accreditation Council (EAC) accredited programs maintain quality standards during the COVID-19 pandemic. In this 'new' norm, engineering education's effectiveness must be upheld and ensure the quality profession is adequately prepared without compromising the accreditation standards. Furthermore, as a Washington Accord member, BEM was recognized as equivalence in accrediting qualifications for an engineering program through the Outcome-Based-Education (OBE) approach. Various assessment methods have been implemented to assess the OBE achievement at the higher learning institution. Due to better control and access data of students up until graduation, Course Outcome (CO) and Programme Outcomes (PO) are more conducive assessments and therefore received more attention and better expectations in the accreditation process [6]. Furthermore, the POs stipulated in the International Engineering Alliance's graduate attributes serve as the benchmark of standards for engineering education of higher learning institutions in Malaysia, as well as other signatory countries under the educational accords [7]

Online and blended teaching and learning in Engineering faculty is not new. Even before the MCO, e-learning portals have been actively used and enabled online student resources and lecture notes, task-based and assignment guides and submissions, interactive lectures, etc. The flexible modes of delivery using MOOCs, flipped classrooms, and informal learning spaces have influenced higher education teaching and learning [8] and regarded as the modern educational approach. The blended online learning has been perfected with face-to-face teaching sessions, tutorials, and project-based sessions. Kamaluddin et al. [9] reveal that stay-at-home/online learning had affected Malaysian students' socio-psychological that cause anxiety yet submissive coping strategies. Being primarily learning online would be challenging as an engineering education program's unique features are practical hands-on laboratory/ instrumentation design experiences [10]. The necessary practical engineering experience is essential to support and prepare future engineers to function as professional engineers [11], which depends highly on the engineering subject's nature.

This study aims to investigate the course learning performance despite the remote learning due to MCO and COVID-19 challenges. The twelve (12) Programme Outcomes (PO (1) to PO (12)) attributes that are expected for Malaysian engineering graduates relate to the skills, knowledge, and behavior of students as described in the EAC Standard [12]. For this paper, we focus on attaining course learning outcomes (CO) to understand and evaluate the sustainability and the impact of professional engineering work on complex engineering problems in societal and environmental contexts. The pandemic has triggered creative teaching and learning to ensure the course outcome is achieved. Modification strategies were highlighted in this work, and the outcomes were measured and analyzed.

2. Methodology

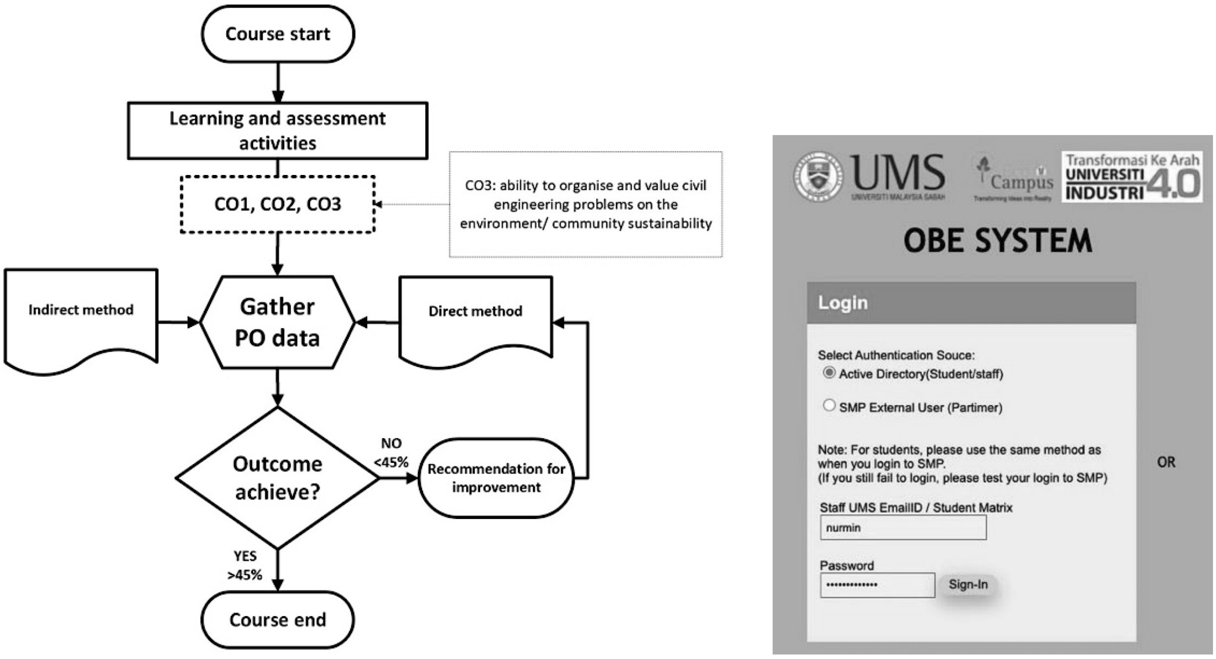
2.1 Case Description and Data Source

Fifty-three final year students of the Civil Engineering Programme of the Faculty Engineering Universiti Malaysia Sabah (UMS) participated in this study. Students enrolled in the environmental engineering course, one of the compulsory courses for Civil Engineering undergraduates. The POs assessed were simplified in Fig. 1(a), and the input was calculated using the institution's in-house UMS-OBE system (Fig. 1(b)). Attendance is also recorded using the UMS-OBE system. The framework for the course studied in this work specifying the environment and sustainability based on EAC [12] is illustrated in Fig. 2.

There were three-course learning outcomes (COs) for the Environmental Engineering subject to be assessed. However, for this paper to focus on evaluation due to pandemic effect, only the 3rd CO was discussed (Fig. 1(a)). The 3rd CO of this subject feature shall include the knowledge profile that involves engineering in society and identified engineering practice issues in the civil engineering discipline of the environmental and sustainability. For this course learning outcome, project-based learning (PBL) pedagogy primarily involves physical and fieldwork as civil engineer experience, which requires learners to organize and value civil engineering problems on the environment sustainability by community participation. The PBL experiential learning has created a constructive learning environment involving building peer networks outside of the classroom, frequent group meetings and mentoring, field works, and various managerial approaches [13].

2.2 2.1 Model Strategies and Survey Sampling Method

The pedagogy method to ensure the course learning outcome (CO3) is achieved is strategized in the following activities, grouped into three phases (shown in Fig. 3). Even before MCO, the PBL has been conducted into 3 phases: planning, implementation, and completion, except that the monitoring and instruction primarily in face-to-face and physical activities. In phase 1, the PBL involves planning and management with a proper proposal and



(a) (b)

Fig. 1. (a) OBE assessment model for PO7 sustainability and environment for the civil engineering program and (b) UMS-OBE system snapshot as direct quantification method of the Cos.

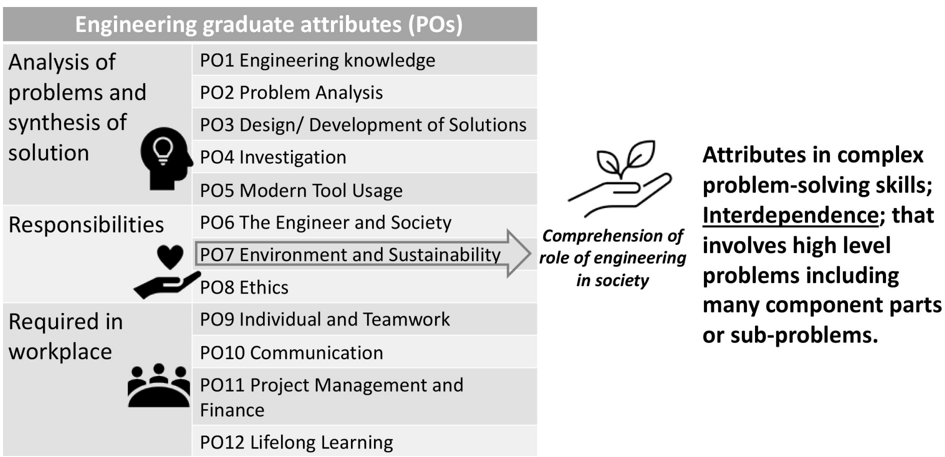


Fig. 2. Engineering graduate attributes or Programme Outcomes (POs) adapted from EAC [11].

financial requirement. While preparing the sustainability project proposal, learners would create a group and formulate the implementation strategies. Previously, the weekly meeting with team members was much direct to manage. However, due to the MCO, an active online platform such as Google Meet, schoology.com, and WhatsApp has been utilized to cater to most of the members' contribution learning progress. Direct communication primarily uses WhatsApp as it is used widely through smartphones, easily accessible, and essential to avoid disruption, especially during synchronous sessions [14, 15].

In phase 2, the implementation includes community engagement and field work to ensure the design is appropriate to the site and local conditions. However, only several students can meet and work with the community involved due to MCO. This district restriction and commitment limitation have merged from five into four projects. In addition, the implementation project needs to be updated online in social media such as Instagram and video implementation for those not physically on-site. The final phase is the project completion that requires learners to provide their final report and individual portfolio.

Due to the pandemic and MCO limitations, PBL progress in the current year must be made in an active online platform compared to the previous year's implementation. However, a very minimal

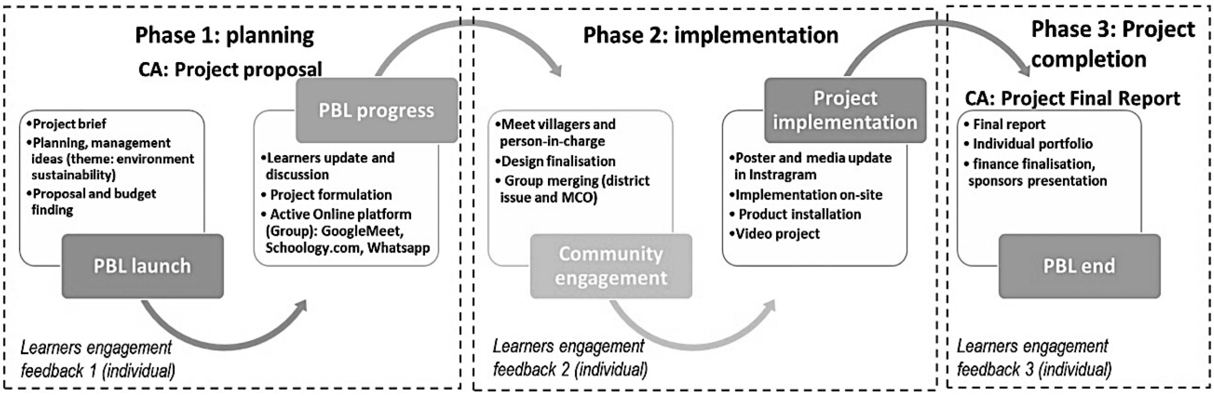


Fig. 3. Pedagogy method and model strategies for the course learning outcome (CO3) during MCO.

reaction from learners was observed during the instruction. Hence some modifications were made to ensure continuous PBL response and PBL completion. Thus, collective to individual adjustment was conducted because some student has been inactively committed or left behind in the PBL by providing Google Form Survey as learners engagement feedback 2 and 3. The Google Form Survey was used to qualitatively measure learners' reactions in terms of self-perception and individual commitment by evaluating their self-performance and course outcome self-rating achievement, which simultaneously as a notice to ensure they tagged along the learning process. Also, to understand student internet capability, a questionnaire survey was given to the learners in the early week of the semester (named learners engagement feedback 1). The learners' feedback 1 is to get the geographic location and internet condition and make sure they can individually cope with the online and remote course teaching and learning seamlessly. According to Ismail et al. [16], compiling their location and internet capability will guide lecturers online sessions. The Pedagogy method and model strategies incorporating learners' engagement using Google Form, as illustrated in Fig. 3, are described in Table 1.

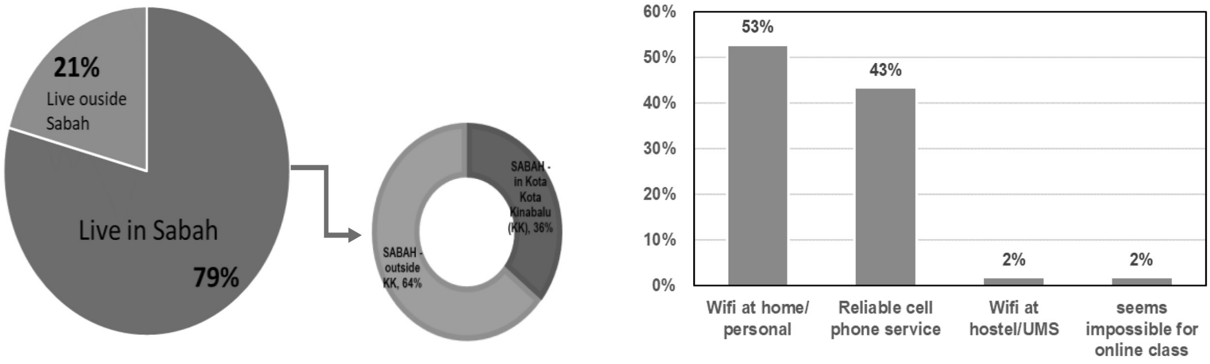
3. Data Analysis and Results Discussion

3.1 Analysis of Internet Capability, Location Restriction, and Learner's Recommendation Integration

The data illustrated in Figs. 4 and 5; were collected during the first week of the semester to capture the student readiness for online class during the MCO, also named Learners Engagement Feedback 1. The MCO has restricted district travel prohibiting crossing districts by police enforcement, and quarantine was tightened progressively, resulting in significant compliance improvement. As shown in Fig. 3, the learners' demographic shows that 79% live in Sabah, Malaysia, located in Borneo's northern part in the East Malaysia region. However, only 36% of them were in the Kota Kinabalu (KK) city areas and could come to the university campus. From learners' input, 53% have stable Wi-Fi at home and 43% reliable cellphone services, as illustrated in Fig. 4(b). The instructor has consulted immediately and advised those who claimed difficulty in the online class. The majority (53%) of the students have an internet connection that is reported similar to other studies [17], yet cellphones may have limited quota data compared to home Wi-Fi. The internet capability and location restric-

Table 1. Google Form survey method to ensure learners engagement during PBL online teaching and learning

Duration/timeline	Google form survey	Purpose	Data outcome
Phase 1	Student Readiness for Online Course Feedback *(Learner's engagement feedback 1)*	Feedback on how to improve the student learning experience	• Learners demographic location during MCO • Internet/ network capability • Preferred ways to improve their learning
Phase 2	feedback survey on PBL commitment during MCO *(Learner's engagement feedback 2)*	To get student input on reasons/justification for their commitment to the course, particularly the PBL implementation.	• Level of commitment in the PBL
Phase 3	Course evaluation survey *(Learner's engagement feedback 3)*	Learner rate (self-perception) on the achievement of course outcome (COs)	• Self-rating performance level on course outcome (CO3)



(a) (b)

Fig. 4. (a) Demographic of the affected student MCO location and (b) Internet Network capability of the learners-based Student Readiness for Online Course Feedback survey.

tion have insightful information for the instructor in providing materials and teaching and learning pedagogy. It is anticipated that nearly half of the learners may reduce or lost connection during synchronous class, so the lecture session was recorded and accessed once their internet connection was available and could be downloaded.

To cope with their learning, as illustrated in Fig. 5, most of the learners requested recorded video lectures (50% recommended this), and 30% mentioned providing more continuous assessments (CA) such as online quizzes or tutorial answers posted. Most of the suggestions have been implemented by the course instructor to assist their studying. Online lectures synchronous and non-synchronous approaches implemented via recorded GoogleMeet or Webex provided in the e-learning platform. The e-learning platform uses schoology.com, with the second alternative of SmartV3 UMS to facilitate their device preference. Continuous assessment such as quick quizzes during or after each topic was included to ensure students' engagement and learning requirements. The online quizzes were randomized to reduce cheating, and the format changed to increase question and answer reliability. So, most of the feedback has been incorporated in the course especially recorded video lectures, quizzes at the end of each topic, and increased online resources.

Interestingly, as tabulated in Table 2, it was observed that the overall attendance has only a slight decrease (less than 1%) compared to the previous year indicates that students could follow the schedule and formal online classes despite MCO conditions. Understandably, the online lecture class may not be easy to concentrate on and lack classmates' discussion environment, which was noticed during poor class feedback; however, most students have worked their best to adhere to most of the sessions and assessments on time.

3.2 Analysis of the Course Learning Outcome Achievement and Course Grade Performance

The analysis of the achieved course learning out-

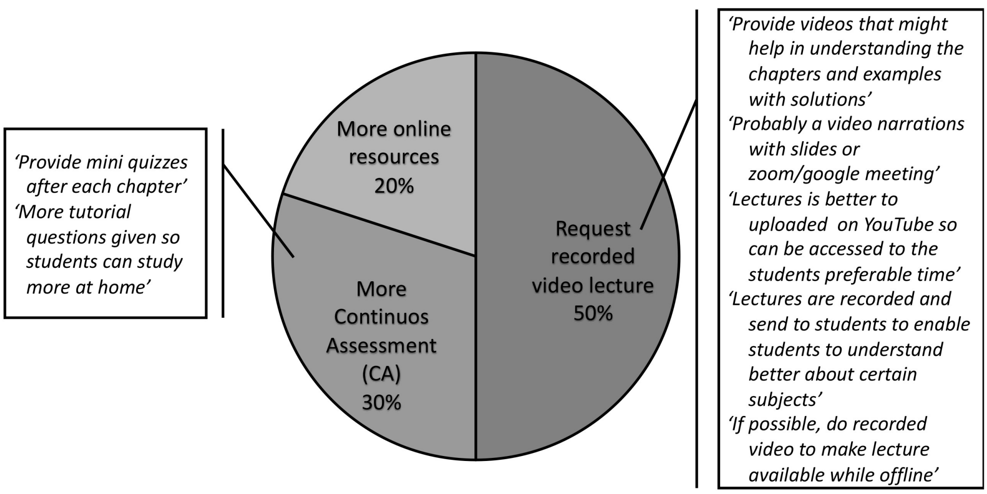


Fig. 5. Feedback by students on ways to improve teaching and learning preference during MCO (surveyed in early semester).

Table 2. Comparison of student attendance during MCO compared to the previous year for the same course

	Affected MCO group	Typical (previous year) group
Mode of learning	Online (non-F2F)	Physical on-campus
Attendance method	Smart-hadir (OBE-UMS) Via link (with time expiration)	Smart-hadir (OBE-UMS) Via QR code (displayed during class)
Fourteen weeks Attendance (Average)	90.7 ± 5.5 %	91.4 ± 5.4%

come and learners' self-perception is presented in Fig. 6. The CO3 is quantified into three data inputs. First is the CO3 assessment marks provided by the course instructor based on the PBL continuous assessment. The PBL continuous assessment marks were based on the proposal, final report, and PBL video implementation. The implemented PBLs are summarized in Table 3. Second is the CO3 self-perception quantified from indirect course outcome via course evaluation survey (Learner's engagement feedback 3) given during phase 3. The third is the level of commitment in the PBL as rated by the learners in their feedback survey on PBL commitment during MCO (Learner's engagement feedback 2) surveyed during phase 2.

Based on the course instructor's assessment marks, most students, 62%, achieved level 4, 28% in Level 3, and 8% in Level 2. The trend seems reasonably similar compared to their CO3 self-perception (Learner's engagement feedback 3) and level commitment (Learner's engagement feedback 2). However, their feedback rating on PBL commitment was more correspondent with the CO3 marks attained. The percent deviation was lesser than 10% deviation compared to the CO3 self-perception by the learners themselves. The lower deviation indicates that the student feedback on their level of commitment rating reflected more near the CO3 assessment marks. This could be correlated with their confidence in the effort given and commitment

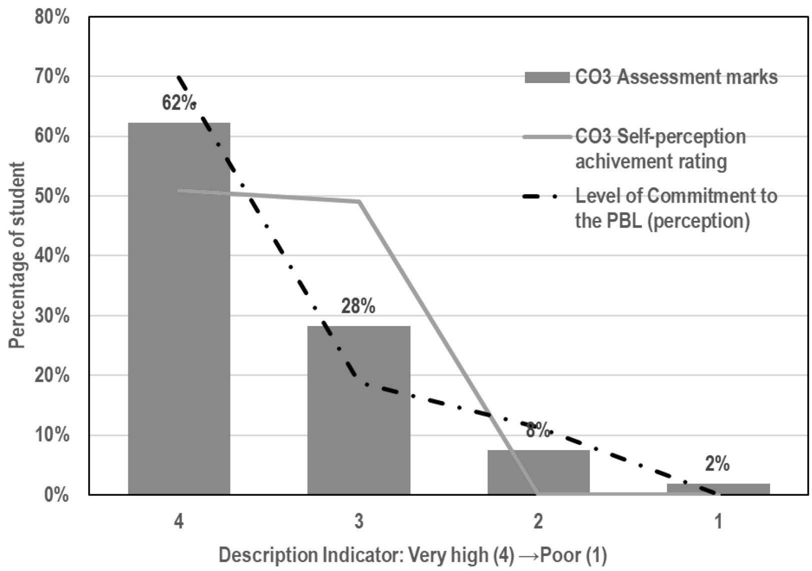


Fig. 6. Course Outcome achievement based on student assessment, student self-perception, and relation to their level of commitment in implementing PBL (CO3).

Table 3. Implemented PBL during MCO for the course outcome continuous assessment

PBL title	Community/industry involved	Financial sponsors	Environment sustainability theme
The Green Ribbon Box	School children (underprivileged)	External	Education for all and recycling awareness program.
Green Thumb	Higher learning institution	External	Upcycling plastic waste into block paver for pedestrian walk.
Clean Water for Everyone (Biochar filter)	Villagers of rural area	External	Knowledge sharing with villagers on clean water in water filtration installation, operation, and maintenance using biochar.
Eco-paver Block	Higher learning institution	Internal	Upcycling agricultural waste into block paver and installed as a garden footpath.

to completing the PBL. The MCO restriction has reduced several of the students' involvement in the fieldwork yet can only contribute to writing reports and desk work. The PBL was strategized by local students (living near university campus) work on field whilst the rest must do desk work. Unfortunately, this might lessen the appreciation and responsibility in fulfilling the project closely. Whereas the CO3 self-perception rating may bit generalized, students have no specific indicator to guide their achievement level. Hence, an indirect measurement using self-perception rating to evaluate own self CO achievement would be more meaningful using particular criteria as shown in this work which is their level of commitment in completing the task/assessment.

Interestingly, based on learners' responses from the feedback survey on PBL commitment during MCO (Learner's engagement feedback 2), they collectively agreed and comprehended several skills to complete the PBL. The student feedback survey has qualitatively signified their required attributes to achieve the task. As shown in Fig. 7, responses were categorized and found that most responses (31%) said they needed to improve teamwork skills to be committed to the assigned task. It is then followed by self-discipline (24%) and time management (18%), communication (10%), and others (10%). Others have mentioned the need for meditation, seeking expertise, strong internet, waiting for vaccines, etc. They realize the importance of teamwork and ensuring self-discipline and focus on avoiding PBL failures. Since the PBL requires fieldwork and outreach with relevant community/industry, they admit the importance of working in a good team, supporting each other, and being responsible for themselves by focusing intensely and having strong motivation even during the MCO condition.

The course grade results were compared between this MCO group and the normal (previous year) group. The data is shown in Fig. 8. It was observed that the distribution percentage grade of the course is slightly reduced, and the normal distribution has skewed more to the left (or lower rate). The UMS-OBE system resulted that the normal group has 100% achieved the linked Programme Outcome (PO), whereas the MCO group achieved 96.2% (Fig. 9). The measured UMS-OBE system (discussed previously in section 2.1) has given an indicator of very good achievement. However, the slightly reduced student grade performance and course outcome achievement showed that the new norm adaptation influences their academic performance. Even though this is subjected to various factors [9] that cause different learning achievements and an abrupt switch to fully online learning has been stressful to both instructors and students who prefer in-person instruction [18]. Besides, the diverging learning style was not incorporated in the study as it may have a dramatic influence on the curriculum delivery changes [19]. However, this case had only considered minimal influence and intent to be improved after the MCO relief. The three fundamental issues, especially in implementing Project-Based Learning, such as students' motivation, supporting students' work and providing

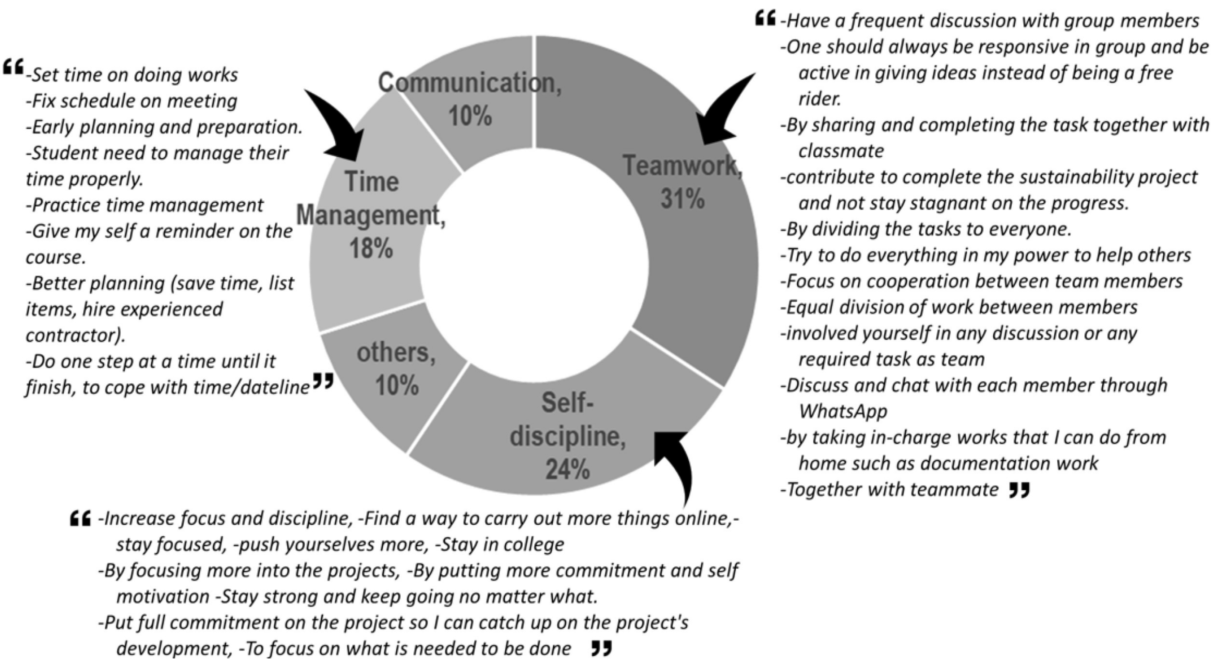


Fig. 7. Feedback by students improves their commitment and learning capacity for carrying PBL (CO3).

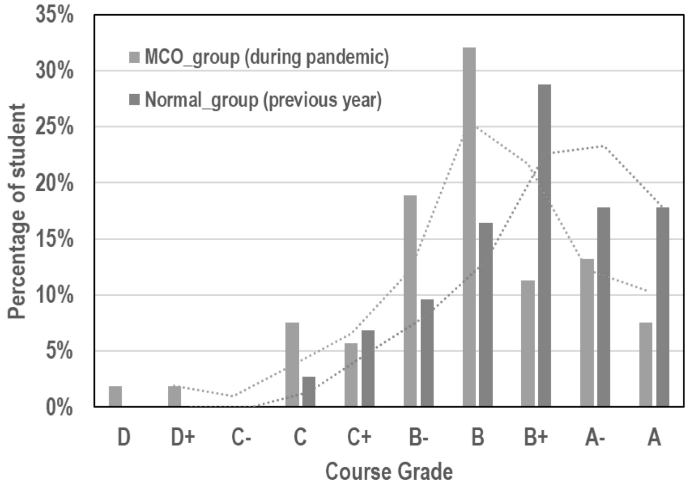


Fig. 8. Comparison of the MCO group and Normal group (previous year) course grade distribution.

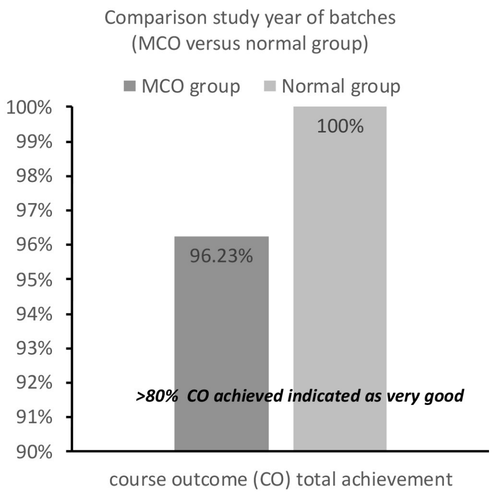


Fig. 9. Comparison of the MCO group and Normal group (previous year) in terms of total CO achievement

feedback, and student autonomous-centered learning [20], should be articulated preferably face-to-face active learning approach.

4. Conclusion

The course outcomes indicate the knowledge and skills learners should acquire at the end of the course. To instill the ability and responsibility on sustainability and impact of professional engineering work, the system embeds Project-Based-Learning involving community or society and environmental context. It consists of defining and designing the project in the proposal stage to reach the relevant communities for tangible and on-site installation. The study analyses the influence of modification in teaching and learning on the Project-Based-Learning (PBL) pedagogy during the COVID-19 epidemic movement-control-order (MCO). We acknowledge the challenges of teaching physical fieldwork that requires community engagement for enhancing environmental sustainability. The primary limitations, such as T&L changes and uncertainty due to MCO, ability to implement and conduct fieldwork, students' commitment, and financial sponsors pressures, has quest for proper modification to ensure T&L can be achieved. The paper concludes that the teaching instruction intervention that includes learners' engagement feedback survey and an online learning approach has elevated the commitment in completing the PBL tasks. Various challenges encountered and intervention in connecting individual learners, strategizing locality, team merging, and increasing direct communication through online platforms to both synchronous and asynchronously are vital to help educators ensure learners achieve the course outcome, as evident in the analysis. Even though the new norm of remote learning slightly reduces (<5%) on the course outcome performance, most learners have exceeded the minimum expected course outcome performance. The pandemic has triggered creative teaching and learning, and we need to leverage that even after the pandemic has ended.

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Contributions – N. Bolong conceptualized the study, analyzed the data, and wrote the paper. I. Saad has been involved in project fieldwork and provides critical feedback. All authors read and approved the final manuscript.

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