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Assessing Psychomotor Domain in Civil Engineering Design Project During Pandemic

Fei Ha Chiew[1], Beatrice Christianus Bidaun[2] and Rudy Tawie Joseph Sipi[3]
[1,2,3]Faculty of Civil Engineering, Universiti Teknologi MARA Cawangan Sarawak, Sarawak, Malaysia

[1]chiewfa@uitm.edu.my; [2]beatricecb@uitm.edu.my; [3]rudy@uitm.edu.my

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ABSTRACT

Previous studies highlighted the challenges in assessing psychomotor skills in engineering education when using online platforms. The main aim of this study was to examine the effectiveness of learning psychomotor skills online in Civil Engineering Design Project during the pandemic. This paper discusses the challenges faced in assessing the psychomotor domain in Civil Engineering Design Project during the pandemic and the immediate actions taken during the semester. New structural engineering software was used as the initial software was not accessible outside campus. The greatest challenge for lecturers was to learn the new software within a short period and to implement the use of the new software in their teaching and learning activities as well as in the students' assessments. New evaluation rubrics were created to assess students' psychomotor skills in using the new software for course assessments. Marks were allocated to each practical skill identified in completing the assessments. Students' grade attainments of the two course outcomes mapped to the psychomotor domain show that more than 85% of students were able to achieve the KPI of 50% for the two course outcomes. This shows that most students were able to grasp the relevant practical skills required in the course when taught via ODL.

Keywords: *Assessment; psychomotor domain; practical skills; challenges; pandemic*

INTRODUCTION

In February 2020, due to the sudden COVID-19 outbreak in Malaysia, all higher learning institutions (HEI) in the country were forced to transform their initial face-to-face (F2F) teaching and learning to open and distance learning (ODL). All UiTM campuses were closed in March 2020, and students were sent home gradually. Instructions to continue all lectures and assessments for the semester in ODL were made in order to ensure the safety of both students and lecturers (Ten, 2020).

Civil Engineering Design Project is a course in the Diploma of Civil Engineering Program of Universiti Teknologi MARA Malaysia (UiTM). The course is considered as a final year project, which is one of the qualifying requirements in the accreditation of Engineering Technology Accreditation Council (ETAC). ETAC is a body delegated by Board of Engineers Malaysia (BEM) to handle the accreditation process for engineering technician qualifications. Hence, it is of utmost importance to make sure that the teaching activities and assessments of the course in ODL satisfy the requirements of ETAC to gain accreditation of the program by professional bodies. Only then, the graduates of the diploma program are accepted to be registered as Engineering Technicians or Inspector of Works with BEM. As ETAC recommended the utilisation of modern multimedia technology and computers in final year projects, it is crucial to make sure that this requirement is fulfilled even in ODL classes.

The Faculty of Civil Engineering adopts twelve (12) program outcomes (POs) stipulated in the Engineering Technician Education Program Accreditation Standard 2019 (Board of Engineers Malaysia, 2019). Among the twelve POs, the fourth PO (to identify and analyse well-defined engineering problems reaching substantiated conclusions using codified methods of analysis specific to their field of activity) and fifth PO (to design solutions for well-defined technical problems and assist with the design of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations) are addressed in the syllabus of the course. These two POs are mapped to the psychomotor domain. At the same time, the course also needs to comply with the Malaysian Qualification Framework (MQF) psychomotor learning outcome cluster, namely functional work skills that focus on practical skills, interpersonal skills,

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communication skills, digital skills, numeracy skills, leadership, autonomy and responsibility (Malaysian Qualifications Agency, 2017).

Studies (Seth & Haron, 2016; Potkonjak et al., 2016) have shown that it is a big challenge to deliver and assess psychomotor skills effectively to achieve the learning outcomes in engineering education via ODL. It is difficult to assess students' psychomotor skills when both lecturers and students are not physically present in the same room. The objective of the paper was to study the effectiveness of learning psychomotor skills online in Civil Engineering Design Project during the pandemic. This paper discusses the challenges faced in assessing the psychomotor domain in the course during the pandemic and the immediate actions taken during the semester to ensure that all learning outcomes are achieved and all teaching activities and assessments conducted via online mode satisfy the requirements of both MQF and ETAC. Students' attainments of the Cos and Pos related to the psychomotor domain were compared with those of the previous semester. An online questionnaire was distributed to get feedback from students on their learning of psychomotor skills via ODL.

PSYCHOMOTOR DOMAIN EVALUATION IN CIVIL ENGINEERING DESIGN PROJECT

In Civil Engineering Design Project, students are given a project of a two-story reinforced concrete building. Students are given a set of architectural drawings of a two-story reinforced concrete building and taught to use engineering software to conduct structural analysis and design for structural elements of the building. Students' practical skills to use engineering software to perform structural analysis and design for structural elements of their reinforced concrete buildings and to draw structural detailing for the structural elements using drawing software are associated with the psychomotor domain. Two course outcomes (Cos) which are mapped to the psychomotor domain are shown in Table 1.

Table 1: Mapping of Course Outcome to Program Outcome Related to Psychomotor Domain

Course Outcome (CO)	Program Outcome (PO)	Taxanomy Domain	Assess-ment
CO1: Construct civil engineering design projects in accordance with relevant codes of practice	PO4: Identify and analyze well-defined engineering problems reaching substantiated conclusions using codified methods of analysis specific to their field of activity	P4	Project Technical Report
CO2: Utilise appropriate techniques in civil engineering design project within the scope and limitations.	PO5: Design solutions for well-defined technical problems and assist with the design of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	P5	Practical Test

The course assesses psychomotor skills in project technical report and practical test. In a normal F2F class, teaching and learning activities take place in a computer laboratory for seven (7) hours per week with both lecturers and students physically present in the same room. After demonstration on software use by the lecturer, students use computers and modern technology software (ESTEEM and AutoCAD) in the computer laboratory to complete their reinforced concrete design project. This work will be carried out throughout the semester and supervised weekly by the lecturer. At the end of the semester, students will compile all their work and submit a complete technical report to be evaluated as 10% of the total course assessment. The practical test carries 20% of the total course assessment. This practical test is conducted at the end of the semester. During the test, students are given problems related to structural analysis and reinforcement design of structural elements (slab, beam, column and pad footing). To solve the problems, they need to use the ESTEEM software. The practical test is conducted in the computer laboratory and monitored by the lecturers who are physically present. Outputs from the software are saved and submitted to the lecturer at the end of the test.

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CHALLENGES IN ASSESSING PSYCHOMOTOR DOMAIN IN ODL

As the transformation from F2F to ODL happened overnight, inevitably, a few challenges were faced in the delivery and assessment of the psychomotor domain of the course. The challenges are discussed as follows:

Accessibility of Engineering Software

When UiTM Sarawak Campus was shut down in March 2020 due to the COVID-19 pandemic, both lecturers and students of the course were not able to access the initial licensed engineering software (ESTEEM) from outside campus. This software can only be accessed via intranet. Immediate attempts to find an alternative structural engineering software which could be accessible from outside the campus were made. The use of engineering software is crucial to fulfill the ETAC final year project requirement of utilization of modern technology and use of computers and multimedia technology. This is stipulated in the Guiding Principles on Teaching-Learning and Assessment Implementation during Covid-19 Pandemic by Board of Engineering Malaysia (Board of Engineers Malaysia, 2020). The challenge was to be able to create teaching and learning activities suitable for psychomotor skills' learning implementation and assessment within a short period. Both lecturers and students had to apply for free educational licenses of new structural engineering software (PROKON) and drawing software (AutoCAD) to be used for the semester. Lecturers had to learn to use the PROKON structural element design modules in a short period of time before they can teach the students.

Internet Connectivity and Students' Accessibility

When students were sent home, some students in rural areas faced poor internet connectivity problem. Students who did not have computers at home were urged to find ways to either purchase computers or borrow from their friends and relatives in the midst of Malaysia's Movement Control Order period. Two students were only able to get their computers after one month of ODL classes. Students had to install the required structural engineering and drawing software in their computers. During F2F classes, students could easily make use of the computers and software available in the computer laboratory. However, with ODL, students need to be proactive and well-equipped with required information and communication technology devices for online learning.

For synchronous learning, demonstration of software used by the lecturers was done using online meeting platforms such as Google Meet and was recorded and uploaded in Google Classroom. In this way, students who were not able to join the online class could download and watch the demonstration videos at a later time. All students were able to watch the videos uploaded in Google Classroom repeatedly to learn the steps on how to use both engineering and drawing software for their project. Interactions between lecturers and students also occurred in Google Classroom and WhatsApp platforms, where students asked questions and received replies from the lecturers during asynchronous learning. Both students and lecturers had to learn and adopt the use of online platforms for ODL in a short period of time.

Lack of F2F Learning Interactions

Even though students met their lecturers virtually during synchronous learning and were able to communicate with the lecturers in Google Classroom and WhatsApp platforms, there was still a lack of F2F contact. In normal F2F classes, both lecturers and students are physically present in the same space for 7 hours per week. Therefore, lecturers could monitor students' learning progress and give immediate feedback. Students could ask questions easily when the lecturer is right in front of them or discuss with their classmates in physical classes. However, these invaluable interactions are very much limited during ODL. Students who come from traditional instructor-centered educational background could easily lose their motivation when they are not able to communicate with their lecturers and classmates to get the support that they were used to (Dzakiria, Idrus, & Atan, 2005).

Preparing and Monitoring Practical Test

In order to avoid plagiarism during the practical test, a few sets of questions were prepared and were randomly distributed to the students. Students were given 2 hours to complete the questions using the same engineering software that they learned. They were required to sign an integrity declaration not to plagiarize or communicate with each other during the test. Questions were given to the students in Google Classroom and students were required to upload their input pages, analyses and design results pages from the software in Google Classroom. Although students were required to switch on the computer's web camera during the practical test, some students' computers were not equipped with the device and were not able to be monitored accordingly. A longer period of submission was allowed for students who had poor connectivity as they require a longer time to upload their answers in Google Classroom. It was a bigger challenge in monitoring students' practical test in ODL compared to F2F, where the lecturers can monitor their students physically and control the duration for students to complete the questions and submit their answers.

METHODOLOGY

As the initial engineering software was not accessible, new psychomotor domain evaluation rubrics had to be created to suit the features of the new engineering software. This section explains the identification of practical skills and the development of evaluation rubrics for the two course outcomes that are mapped to psychomotor domain.

Psychomotor Domain Evaluation Rubrics

Simpson (1972) outlined seven (7) categories in the mastery of a skill that include physical movement, coordination and use of motor skill areas. Table 2 shows the seven categories and their respective descriptions of Simpson's Psychomotor Domain.

In a study by Kasilingam et al. (2014), lecturers identified practical skills related to the electronic laboratory experiments of students and did a mapping of the practical skills to Simpson's Psychomotor Domain (Table 3). The study used the mapping in Table 3 to develop an assessment rubric which was designed based on the tasks of the laboratory experiments and the laboratory practical test.

Table 2: Seven Categories and Descriptions of Simpson's Psychomotor Domain (Simpson, 1972; Kasilingam & Chinnavan, 2014; Sottilare & LaViola, 2016)

Level	Category	Description
P1	Perception	Ability to use sensory cues to guide motor activity.
P2	Set	Readiness of mental, physical, and emotional aspects that make one respond in a certain way to a situation.
P3	Guided response	First attempts to practice skills with guidance.
P4	Mechanism	Perform simple acts with increasing efficiency and confidence.
P5	Complex overt response	Perform practical skills with complex motor movements.
P6	Adaptation	Modify movement patterns to meet special problem/ situation.
P7	Origination	Create new movement patterns to account for problematic / new situation.

Table 3: Mapping of Practical Skills to Psychomotor Domain (Kasilingam & Chinnavan, 2014)

Practical Skills	Psychomotor Domain
Able to name and identify the components	Perception
Able to draw the relevant circuit	Perception
Able to explain the working principle	Perception
Develop circuit diagram based on design values	Mechanism
Implement circuit diagram	Guided response
Theoretical evaluation of outputs	Guided response
Comparing theoretical and practical values	Guided response
Understanding of experiment	Adaptation

Ferris and Aziz (2005) proposed a psychomotor domain hierarchy based on students' learning outcome. The hierarchy consists of seven (7) levels which include (i) recognition of tools and materials, (ii) handling of tools and materials, (iii) basic operation of tools, (iv) competent operation of tools, (v) expert operation of tools, (vi) planning of work operations and (vii) evaluation of outputs and planning means for improvement. According to the authors, it is necessary for engineering students to develop skills related to their discipline, as engineers need to be equipped with psychomotor skills in performing work related to developmental experimentation, prototyping, maintenance and construction.

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The evaluation rubrics for assessing the psychomotor domain in Civil Engineering Design Project were based on Simpson's Psychomotor Domain taxonomy. Students are required to achieve level P4 (mechanism) for CO1 (to be able to construct civil engineering design projects in accordance with relevant codes of practice) and level P5 (complex overt response) for CO2 (to be able to utilise appropriate techniques in civil engineering design project within the scope and limitations). Two evaluation rubrics were developed: one rubric for one course outcome. These two rubrics were revised to suit the PROKON engineering software that was used during the pandemic. New evaluation rubrics were required as previous evaluation rubrics were based on the ESTEEM software, where students were taught to do 3D modelling and structural design for the whole building. The practical skills required in 3D modelling include setting up of gridlines, columns, beams and slabs positions for the whole building in ESTEEM. Load transfer to structural elements in 3D modelling is automatically calculated by ESTEEM. In contrast, during the pandemic, students were taught to use PROKON structural element design modules to perform structural analysis and design for only selected structural members of the building. Students did not perform 3D modelling using PROKON. Therefore, practical skills in 3D modelling (setting up of gridlines, columns, beams and slabs positions for the whole building) were not required. Students had to calculate load transfer to the selected structural elements themselves. In designing the new evaluation rubrics, the activities for each CO with the related practical skills were identified. The practical skills were then mapped to the psychomotor domain. Table 4 shows a mapping of activities and the associated practical skills to Simpson's Psychomotor Domain for CO1. In ODL, students were shown how to use the new engineering software via Google Meet before they conducted the activities for their projects on their computers. Activities for assessing attainment of CO1 were conducted during normal class hours. Students were required to submit their input page, loading page, analyses and design results pages from the software for selected structural elements (software outputs) in Google Classroom. At the end of the semester, students were to compile all software inputs and outputs for their project as part of their project technical report.

Table 4: Mapping of Practical Skills to Psychomotor Domain for CO1

Activity	Practical Skills	Psychomotor Domain
Prepare a project schedule	Able to produce a project schedule with use of software	P3: Guided response
Prepare structural key plans for the building	Able to produce correct structural key plans with use of software, with correct markings and drawing scale	P3: Guided response
Structural Element Analysis and Design: a) Slab design for selected slab b) Staircase design for selected flight c) Beam design for selected beams d) Column design for selected column e) Footing design for selected footing	Able to identify and choose suitable software to perform structural element design	P1: Perception
	Able to find loadings and design parameters for the structural element	P4: Mechanism
	Able to conduct structural analysis and design for the structural element using software	P4: Mechanism
	Able to draw detailing of the structural element using software	P4: Mechanism
	Able to follow the correct code of practice	P4: Mechanism

Table 5: Mapping of Practical Skills to Psychomotor Domain for CO2

Activity	Practical Skills	Psychomotor Domain
Practical test	Able to identify and choose suitable software/ module to perform structural element design	P1: Perception
	Able to key-in design parameters for materials in the software	P2: Set
	Able to key-in parameters for structural elements	P3: Guided response
	Able to identify and key-in loadings for structural elements	P3: Guided response
	Able to conduct structural analysis for structural elements	P4: Mechanism
	Able to identify critical forces/ moments for structural elements	P4: Mechanism
	Able to perform design for structural elements for critical forces/ moments according to code of practice	P5: Complex overt response
	Able to save required inputs and outputs from the software	P4: Mechanism
	Able to carry out analysis to solve problems in standardized ways	P4: Mechanism

For the practical test, students were given a set of questions related to structural element analysis and design. Students were required to solve the questions using the engineering software that they have learned. Practical skills required to solve the given questions were identified, and the mapping of the associated practical skills for the practical test to the psychomotor domain (for attainment of CO2) is shown in Table 5. Software inputs and outputs which included all design parameters, inputs, analyses and results from the software were submitted in Google Classroom at the end of the test. Based on the inputs, parameters and results from students' submissions, lecturers were able to check if the tasks were done correctly. Lastly, marks for each practical skill were decided based on the percentage of work done correctly.

The evaluation rubrics used to measure the attainment of CO1 and CO2 based on the psychomotor domain levels are given in Tables 6 and 7, respectively. Each practical skill was given a scale of 0 to 5, where 0 is given if a student was not able to perform the activity, 1 for performing the activity with accuracy of less than 30%, 2 for accuracy between 30% to 50%, 3 for accuracy between 50% to 70%, 4 for accuracy between 70% - 90%, and 5 for accuracy of more than 90%. For the practical test evaluation (Table 7), a bigger scale was given for the skill to perform design for structural elements involving critical positions/ forces/ moments according to the code of practice. This is because students were required to conduct more steps of structural design using the software for each critical position of the structural elements. The marks obtained for each student from performing all the activities in each rubric were totalled up and converted to marks upon 100% to obtain student's attainment of the respective CO and PO of the course. The formula for students' attainment of CO1 and CO2 are given in Examples (1) and (2), respectively.

$$\text{Attainment of CO1} = \frac{\text{marks obtained}}{50} \times 100 \tag{1}$$

$$\text{attainment of CO2} = \frac{\text{marks obtained}}{45} \times 100 \tag{2}$$

For this course, students' attainment of CO1 is also their attainment of PO4, because the assessment assigned for both CO1 and PO4 is the same. Similarly, students' attainment of CO2 is the same as their attainment of PO5.

Table 6: Psychomotor Evaluation Rubric for Attainment of CO1

Psychomotor Domain	Practical Skill	Rubric Scale					
		0	1	2	3	4	5
P3: Guided response	Produce a project schedule with use of software	Unable to produce a project schedule	Able to produce a project schedule but with errors. Less than 30% of the activities are correct	Able to produce a project schedule but with errors. 30%-50% of the activities are correct	Able to produce a project schedule but with some errors. 50-70% of the activities are correct	Able to produce a project schedule but with some errors. 70-90% of the activities are correct	Able to produce a project schedule accurately. More than 90% of the activities are correct
P1: Perception	Identify and choose suitable software/ module to perform structural element design	Unable to use any software	Able to use suitable software to perform structural design for less than 30% of structural elements	Able to use suitable software to perform structural design for 30% - 50% of structural elements	Able to use suitable software to perform structural design for 50% - 70% of structural elements	Able to use suitable software to perform structural design for 70% - 90% of structural elements	Able to use suitable software to perform structural design for more than 90% of structural elements
P4: Mechanism	Produce detailing of structural elements using AutoCAD	Unable to produce any detailing of structural elements using AutoCAD	Able to produce a few detailing using AutoCAD but with errors. Less than 30% of detailing are correct	Able to produce some detailing using AutoCAD but with errors. 30% - 50% of detailing are correct	Able to produce all detailing using AutoCAD but with errors. 50% - 70% of detailing are correct	Able to produce all drawings/ detailing using AutoCAD with few errors. 70%-90% of detailing are correct	Able to produce all detailing using AutoCAD accurately. More than 90% of detailing are correct

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Table 7: Psychomotor Evaluation Rubric for Attainment of CO2

Psychomotor Domain	Practical Skill	Rubric Scale					
		0	1	2	3	4	5
P1: Perception	Identify/ choose the appropriate software/ module to solve the problems	Unable to identify/choose any correct software/ module to solve any problems	Able to identify/choose few correct software/ module to solve some problems. Less than 30% of problems are solved with the correct software/ module	Able to identify/choose some correct software/ module to solve the problems. 30%-50% of problems are solved with the correct software/ module	Able to identify/choose some correct software/ module to solve the problems. 50%-70% of problems are solved with the correct software/ module	Able to identify/choose the correct software to solve most problems. 70%-90% of problems are solved with the correct software	Able to identify/choose the correct software/ module to solve all problems. More than 90% of problems are solved with the correct software/ module
P2: Set	Inputs of design parameters for materials in software/ module	Unable to put in any design parameter as input in software	Able to put in some design parameters as inputs in software but with errors. Less than 30% of design parameters are key-in correctly.	Able to put in some design parameters as inputs in software but with errors. 30%-50% of design parameters are key-in correctly.	Able to put in most design parameters as inputs in software but with errors. 50%-70% of design parameters are key-in correctly.	Able to put in all design parameters as inputs in software with few errors. 70%-90% of design parameters are key-in correctly.	Able to put in all design parameters as inputs in software accurately. More than 90% of design parameters are key-in correctly
P3: Guided response	Able to key-in structural elements parameters	Unable to key-in structural elements parameters	Able to key-in some structural elements parameters but with errors. Less than 30% of the parameters are correct.	Able to key-in some structural elements parameters but with errors. 30%-50% of the parameters are correct.	Able to key-in most structural elements parameters but with errors. 50% -70% of the parameters are correct.	Able key-in all structural elements parameters with few errors. 70%-90% of the parameters are correct.	Able to key-in all structural elements parameters accurately. More than 90% of the parameters are correct.
P4: Mechanism	Able to conduct structural analysis for structural elements	Unable to conduct any structural analysis for structural elements	Able to conduct structural analysis for some structural elements but with errors. Less than 30% of the analysis results are correct	Able to conduct structural analysis for some structural elements but with errors. 30%-50% of the analysis results are correct	Able to conduct structural analysis for most structural elements but with errors. 50%-70% of the analysis results are correct	Able to conduct structural analysis for all structural elements but with errors. 70%-90% of the analysis results are correct	Able to conduct structural analysis for all structural elements accurately. More than 90% of the analysis results are correct
P5: Complex overt response	Perform design for structural elements for critical positions/ forces/moments according to code of practice	Unable to perform any design for structural elements	Able to perform design for structural elements but with errors. Less than 30% of the design results are correct	Able to perform design for structural elements but with errors. 30%-50% of the design results are correct	Able to perform design for structural elements but with errors. 50%-70% of the design results are correct	Able to perform design for structural elements but with errors. 70%-90% of the design results are correct	Able to perform design for structural elements accurately. More than 90% of the design results are correct

RESULTS AND DISCUSSIONS

Students' attainment in psychomotor skills is assessed by students' grade for a particular CO or PO to measure whether they have achieved the key performance indicator (KPI) set by the Faculty of Civil Engineering UiTM (50% or grade C). Figure 1 shows students' grade attainments of CO1 and PO4. 87.5% of total students were able to achieve the KPI and 31.2% of total students managed to obtain marks of 80% and above (grade A and A+). Students who failed to score the targeted KPI were those who did not submit their work for all the required tasks and were not able to use the correct inputs and design parameters in their work.

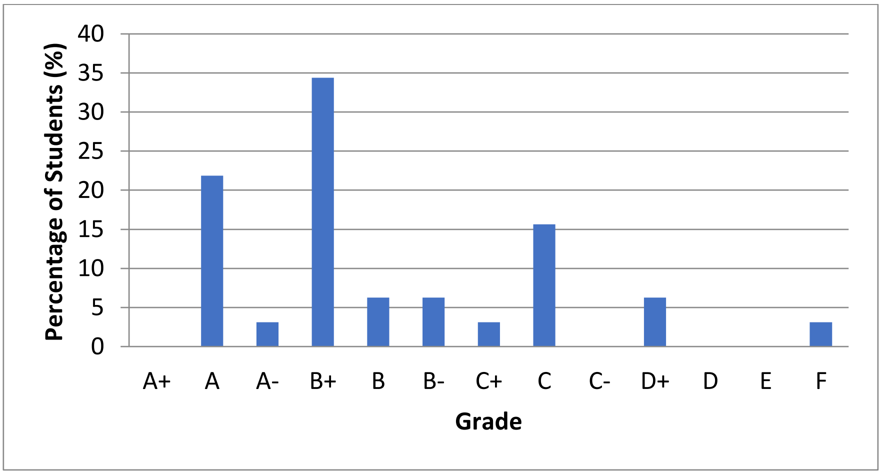

Figure 1: Current Semester Students' Attainment of CO1 and PO4

Students' grade attainments of CO2 and PO5 (based on practical test marks) are shown in Figure 2. 90.63% of total students were able to achieve the KPI, where 21.88% of students scored 80% and above (grade A and A+). Students who received marks of less than 50% failed to submit their answers for all questions in the practical test. This is probably because these students were not able to complete all their answers and submit within the given time. This too indirectly, shows that students who scored less than 50% were not familiar with the software operations and were unable to grasp the skills required to use the software.

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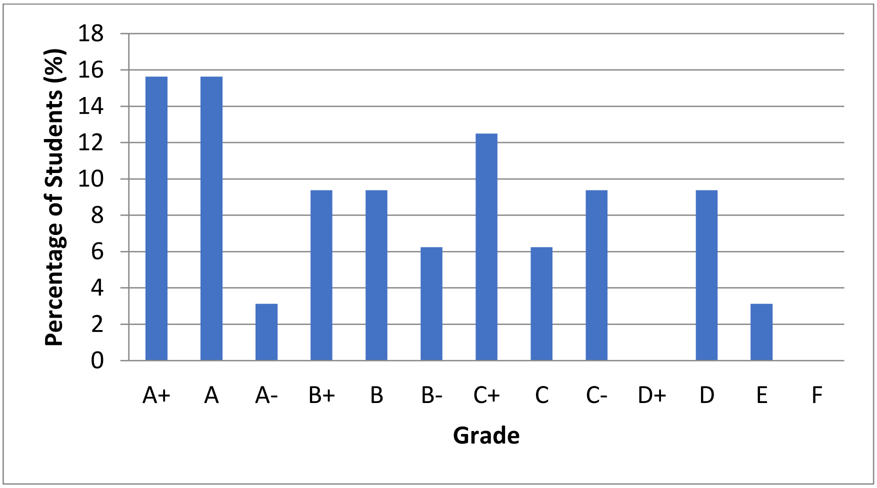

Figure 2: Students' Attainment of CO2 and PO5

Students' results in both assessments show that most students were able to grasp the relevant practical skills required in both the project and the practical test (based on KPI achievements). Some common mistakes among students include: (i) wrong inputs and design parameters, (ii) wrong loadings and (iii) task incompletion.

Comparison with Previous Semester

In the previous semester, software learning and practical test were conducted F2F in the computer laboratory. Figure 3 depicts a comparison between CO1 and PO4 attainments for students from the current semester with those of the previous semester. Overall, students from the previous semester performed better in CO1 and PO4 attainments. A higher percentage of students from the previous semester obtained grades A (40.7%) and A- (46.3%). In comparison, 15.6% of current semester students scored Grade A and 3.1% achieved grade A-. Nevertheless, a higher percentage of students in the current semester attained grade A+ (15.6%) while only 7.4% of students from the previous semester attained the same grade. 94.4% of students from the previous semester were able to obtain a minimum grade of A- in their CO1 and PO4 attainments. For the current semester, only 34.3% of students attained a minimum grade of A-. All students from the previous semester achieved the Faculty's KPI (grade C) in their CO1 and PO4 attainments. The results reveal that F2F classes are more effective in helping students learn psychomotor skills related to CO1 in the course.

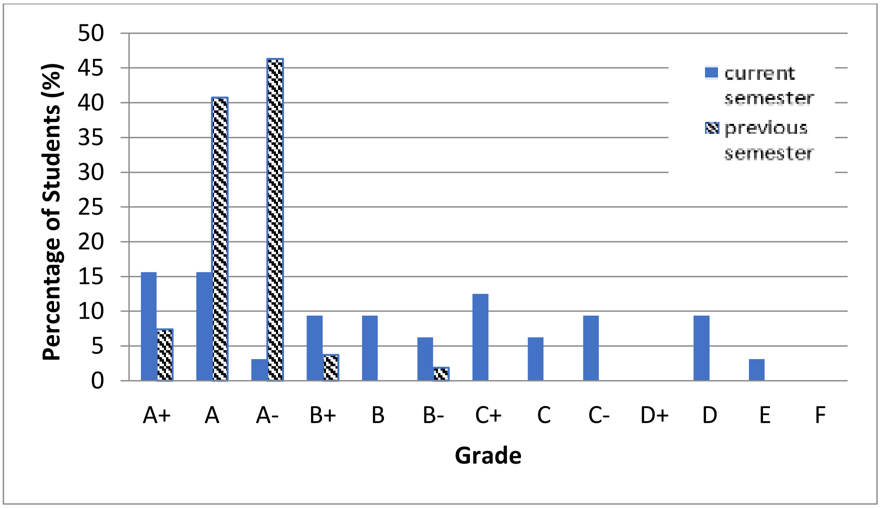

Figure 3: Comparison of CO1 and PO4 Attainments with Previous Semester

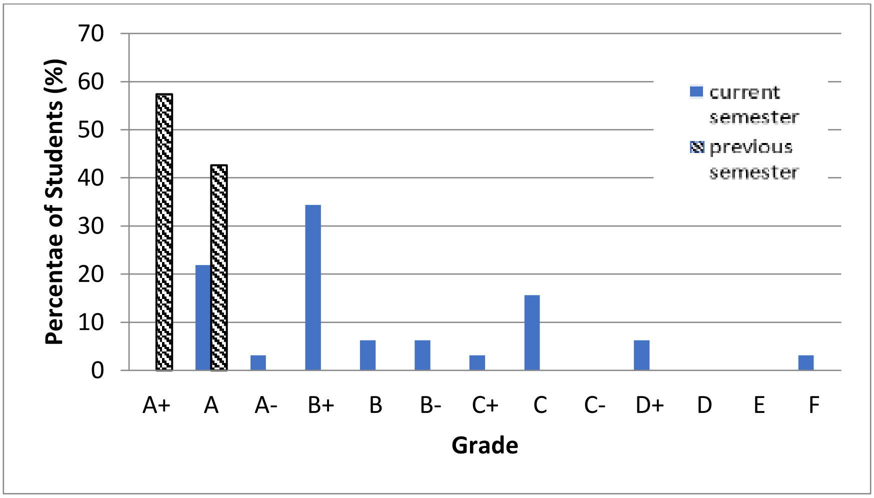

Figure 4: Comparison of CO2 and PO5 Attainments with Previous Semester

Figure 4 shows a comparison of CO2 and PO5 attainments between the current semester and the previous semester students. All students from the previous semester successfully obtained grade A and above, with 57.4% achieving grade A+ and 42.6% obtaining grade A. In the current semester, only 21.88% of students scored grade A and above. This indicates that F2F classes are more effective for learning psychomotor skills related to CO2 in the course.

Feedback from Students

In order to get feedback from students on their experience of learning psychomotor skills online, a short online questionnaire was distributed at the end of the semester. The responses of students on the challenges during ODL revealed that 33.3% of students experienced poor or unstable internet connections during the semester and 16.7% of students encountered problems of lagging in software operation (due to poor performance computers). 33.3% students preferred F2F classes and found it difficult to have discussions with lecturers or classmates during online classes.

Figure 5 depicts the responses from students on the effectiveness of learning engineering software via ODL. 41.7% of student agreed that learning software via ODL was effective, and 50% disclosed that learning software online was “somewhat effective”. The remaining 8.3% chose “Not effective”. These responses show that most students felt they were able to learn using the software online, but it was not as effective as F2F (this matched their response on the challenges of ODL). Another question is on the students’ opinion of the online materials and recordings provided by lecturers in learning the software (Figure 6). 58.3% believed that the materials and recordings were very helpful. This means that more than 50% of students had referred to the materials and recordings provided by their lecturers and found the materials were useful in helping them to conduct their project using the software. However, students who preferred F2F guidance would choose “Somewhat helpful” (29.2%) or “Not helpful” (12.5%). Some students stated a preference for full guidance as in F2F classes, where they can ask the lecturers or classmates directly while using the software in the computer laboratory. An interesting finding from the responses is that several students did enjoy learning the software online and are able to grasp the practical skills required. A few students even mentioned that they think ODL is as good as learning in the physical class.

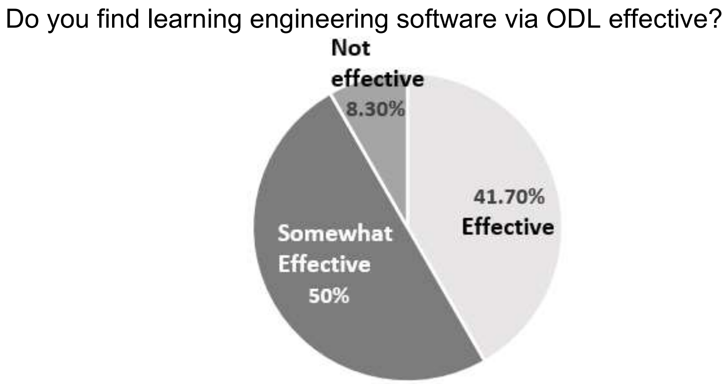

Figure 5: Response from Students on Effectiveness of Learning of Software via ODL

Figure 6: Response from Students on Online Materials and Recordings for Learning of Software

A few questions on practical skills related to the practical test were asked. Students were required to self-evaluate their ability to perform the skills using the software during the practical test. The responses from the questionnaire are shown in Table 8. When students were asked whether they were able to identify and choose a suitable module to perform structural element design during the practical test, 91.7% chose "Yes" while the remaining 8.3% chose "Not sure". This shows that 8.3% students lacked confidence in choosing suitable modules during the practical test. The reason is probably because they did not have adequate practice to familiarize themselves with the software. When they were asked whether they were able

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to key-in design parameters for materials, 95.8% chose "Yes" and the remaining 4.2% selected "Not sure". Again, this reveals that a small percentage of students were not familiar and not confident in keying-in the correct design parameters for the materials.

Table 8: Response of Students' Self-evaluation for Practical Test

Question	Responses
Were you able to identify and choose suitable software/ module during practical test?	Yes (91.7%) No (0%) Not sure (8.3%)
Were you able to key-in design parameters for materials during practical test?	Yes (95.8%) No (0%) Not sure (4.2%)
Were you able to key-in parameters for structural elements during practical test?	Yes (91.6%) No (4.2%) Not sure (4.2%)
Were you able to identify and key-in loadings for structural elements during practical test?	Yes (75%) No (8.3%) Not sure (16.7%)
Were you able to conduct structural analysis for structural elements during practical test?	Yes (70.9%) No (8.3%) Not sure (20.8%)
Were you able to identify critical forces for structural elements during practical test?	Yes (62.5%) No (8.3%) Not sure (29.2%)
Were you able to design reinforcements for structural elements during practical test?	Yes (91.7%) No (0%) Not sure (8.3%)
Were you able to save required inputs and outputs from software during practical test?	Yes (95.8%) No (4.2%) Not sure (0%)

The responses of students on their ability to key-in parameters for structural elements indicated that 91.6% students had confidence in keying-in correct parameters for structural elements in the software. When further asked on their ability to identify and key-in loadings for structural elements, 75% chose "Yes", 8.3% "No" and 16.7% chose "Not sure". This reveals that 25% students were not confident in finding the values of loadings and keying-in the correct loadings in the software.

For ability to conduct structural analysis for structural elements, 70.9% of students chose "Yes", 8.3% chose "No". The other 20.8% answered "Not sure". Those who chose "No" and "Not sure" for this question were most probably the ones who were not confident with the loadings that they used, and thus were unsure whether their results of structural analysis were correct. Apart from that, 62.5% of the students had confidence in their ability to identify critical forces for structural elements. However, 37.5% of the students (8.3% “Not sure” and 29.2% “Not sure”) reported lacked confidence in identifying critical forces from the software. Forces were displayed in both diagram and text formats in the software, and students were asked to identify the critical forces during the practical test. Therefore, these responses show that more than 60% of students understood the analysis and results of forces displayed in the software. When they were asked on their ability to design reinforcements for structural elements during the practical test, 91.7% of students replied “Yes”. Lastly, the responses of students on their ability to save the inputs and outputs from the software reported that 95.8% of students had confidence in their ability to save them correctly.

From the students’ responses, we found that some students lacked confidence in identifying and keying-in loadings, conducting structural analysis and identifying critical forces during the practical test. These few skills are related to their understanding of the calculation of loadings and effects of the loadings to the structure. Therefore, more effort is required to reinforce students’ understanding of these topics and learning of practical skills in these parts of the project. Apart from that, more examples on software use should be demonstrated and explained during online meetings in order to enhance students’ understanding of the software interface.

CONCLUSION AND RECOMMENDATION

The sudden Covid-19 outbreak in Malaysia forced all tertiary institutions to transform their education delivery and assessments from traditional classrooms to ODL. The pandemic forces both lecturers and students to learn new software and adopt online learning using various digital platforms in a short period of time. In this study, students’ grade analysis for the psychomotor domain shows 87.5% of the total number of students were able to achieve the Faculty’s KPI for CO1 and PO4, and 90.63% of this total were able to achieve the Faculty’s KPI for CO2 and PO5. These results indicate that most students were able to learn the relevant practical skills required in the course via ODL. Even though the performance of current semester students in terms of CO1 and CO2 attainments is not as good as that of the previous semester (F2F classes), learning psychomotor skills associated with software use can still be done via ODL with regular online meetings, recordings of meetings, demonstration videos and online materials. However, lecturers have to bear in mind that students from rural areas have limitations in terms of internet coverage, and therefore efforts to enhance internet access in the rural areas should be made by the local government. Apart from that, both lecturers and students need to adapt to the new mode of communication using technology and online digital platforms and equip themselves with adequate devices in order to ensure that the teaching and learning process can be delivered smoothly.

Future work to test the new evaluation rubrics of the course is recommended. In addition, lecturers will need to continuously learn and improve their online teaching methods for better communication and delivery and improve the effectiveness of online assessments in future semesters.

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