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Assessment of Psychomotor Domain in Hydraulics Laboratory

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Abstract

Graduate students, particularly in engineering courses, are required to have high knowledge in engineering and technical skills. As the technology evolving rapidly, Institutions of Higher Learning should produce qualified graduates to fulfil demand in the engineering industries upon receiving accreditation from the Engineering Technician Education Programme Accreditation Standard (ETAC). A good programme should have proper Programme Outcomes, developed based on three domains from Bloom's Taxonomy that comprised of cognitive, psychomotor and affective. The overall goal of engineering education is to prepare students to practice engineering. Psychomotor domains help students to improve their technical skill. To improve student's technical skills, engineering laboratory courses allow students to apply engineering knowledge and conduct experiment on their own. Their skills will be assessed based on methodology and rubrics. The assessment rubric is a combination of four aspect domains consist of perception, set, guided response and mechanism. The analysis consists of categorizing the students in terms of their performance by comparing between two assessments, Practical Test 1 and 2. The marks obtained by students were evaluated based on four categories; poor, weak, average and good.

Keywords: Technical skills, Engineering knowledge, Psychomotor Domains, Rubrics.

Introduction

Nowadays, technology in Engineering has evolved rapidly with time. Engineering technology requires high knowledge in engineering and application of scientific activities. Technical skills are also important to apply knowledge and scientific activities. Graduate students are required to have those skills as most of them will be working in the industries as engineering technicians in various fields such as technical operation, site supervisor, test laboratory, quality controls and many more. In order to produce a qualified graduate, institutions of higher learning must receive accreditation from the Engineering Technician Education Programme Accreditation Standard (ETAC). The objective of the accreditation is to ensure that graduates of the programme fulfil the minimum academic and practical requirements for registration as engineering technicians (Engineering Technology Accreditation Council, 2019).

Bloom's Taxonomy describes the classification of learning into various domains (Bhargav, 2015). Programme Outcomes (POs) have been developed in designing curriculum for engineering courses based on three domains from Bloom's Taxonomy which are cognitive, psychomotor and affective. There are twelve (12) POs for Diploma Programme in Civil Engineering (EC110) in Universiti Teknologi Mara. These POs refer to the general attributes of knowledge (cognitive), skills (psychomotor) and behaviour (affective) that students should know and able to attain upon their graduation

The assessment created for all the courses in the programme must be suitable for students to achieve all the POs and the domains. The overall goal of engineering education is to prepare students to practice engineering (Daud, 2018). Psychomotor domains help students to improve and nurture their technical skill. Psychomotor domain is very important as engineering students need to develop their technical skills (Baharom, 2015). The psychomotor domains of perception, setup, response, controlled movement and mechanism should be applied in all teaching methods, teaching strategies and practical workshops. Psychomotor in learning is present in physical skill with the demonstration of equipment or tools in the classroom, workshop and laboratory (Ahmad, 2018).

Previous researches have shown that laboratory experiment helps to encourage student's ability to

practice technical skills. Through laboratory experiments, the student will have the opportunity to experience and practice their practical and hands-on skills (Baharom, 2015). To make sure students achieve the required psychomotor skill, a set of assessment must be created that able to measure student's skill according to different aspects. A complete methodology and proper rubrics for assessment must be developed and planned in order to achieve the programme's outcomes. Thus, the objective of this research is to measure the effectiveness of tools and delivery method of psychomotor assessment for Basic Hydraulics course.

Methodology

Basic Hydraulics is a core subject for year two students in the Faculty of Civil Engineering (FCE) at the University of Technology MARA, UiTM. This course deals with the laboratory works on fluid and hydraulic areas covered in pre-requisite subject and embedded subject in year two. The assessment on this course covers practical tests, observation on laboratory works and final examination. Psychomotor domain was assessed based on the practical tests. The psychomotor domain on this course measured the ability of students to investigate well-defined problems through experiments conducted following the standard tests and measurements.

Laboratory works for all courses in FCE were conducted based open-ended system. The open-ended system for the laboratory is conducted where the experiments are not fully guided as compared to the traditional method. It enhances students' independent learning through their innovative and creative thinking to solve problems given by conducting experiments. For this course, the open-ended laboratory levels are Level 0 and Level 1, which is suitable for the students' level for year two at the programme level. Level 0 is known as the traditional method for teaching and learning for laboratory class, while Level 1 is an open-ended laboratory with 33% level of openness. For Level 1, students were given preamble, problem statement, and ways and means for students' references before conducting the experiments. However, the data to be obtained and analysed were not guided in the laboratory manual. Students in a group need to explore what data to be obtained and analysed based on the problem statement, objectives and equipment in the laboratory.

Through open ended-laboratory, it helps students to develop competence in executing and applying the experimental work. Students were proposed to acquire the data to be analysed in order to achieve the objectives of the laboratory works depending on the level of openness. The laboratory manual is prepared based on the openness level in OEL for this course.

In the early semester, students were given laboratory briefing on OEL. It is important for students to understand OEL before starting their laboratory works. List of laboratories also was given beforehand based on the level of openness so that students will be prepared every week before conducting laboratory by following the lesson plan. Students worked in a group of a maximum of four students to complete the experimental works and laboratory reports until the end of the semester.

Laboratory reports and observation during experimental works were assessed as a group assessment based on rubrics provided. The group assessment is based on the affective domain while the individual assessment is based on the psychomotor domain. The individual assessment contributed large marks for students and consists of two practical tests. Practical tests were evaluated based on rubrics provided and the same rubric is applied for both tests.

Students' attainments for psychomotor were evaluated for session September 2018 – January 2019. The marks obtained by students were evaluated based on four categories as poor, weak, average and good. The number of students based on the categories achieved was compared and analysed for Practical Test 1 and Practical Test 2.

Result Analysis and Discussion

Table 1 presented the results of Practical Test 1 and Practical Test 2 of students for September 2018 – Jan 2019 session. The analysis consisted of categorising the students in terms of their performance marks, as shown in Figure 1.

Table 1
Performance Marks Categories

Marks	*Category*	*Number of students*	
		PT1	*PT2*
0 – 4	Poor	2	3
5 – 8	Weak	3	1
9 – 12	Average	25	23
13 – 15	Good	46	49

Figure 1
Percentage of Student's Performance Marks

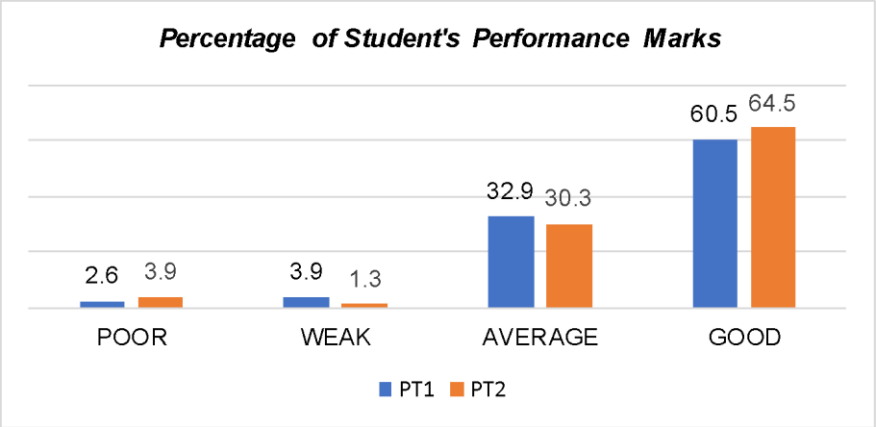

Figure 1 shows the percentage of the student's performance marks for Practical Test 1 (PT1) and Practical Test 2 (PT2). During PT1, about 60.5 % of students were in a 'good' range, 32.9 % were in an 'average' range, 3.9% were in a 'weak' range and 2.6% were 'poor'. Compared to the performance marks during PT2, 64.5% of students were in a 'good' range, where the percentage has increased about 4%. Then, 30.3% were in 'average' range, decreased by 2.6%, 1.3% were in 'average' decreased from 3.9% during PT1 and 3.9% were 'poor' where the percentage increased from 2.6% during PT2. It shows that the students' performance increased because the topics for the PT2 were on Basic Hydraulics. This implies that they learn the theoretical and practical at the same time.

The results also indicated that during the PT1 and PT2, the majority of the students were in 'good' category where they were able to demonstrate almost all the psychomotor skills in order to conduct an experiment. They were able to identify the given problem based on scenario completely, completely displayed the right use of PPE for a laboratory test, set up the equipment within the given time, demonstrate and conduct the experiment with more than 81% completed and demonstrate care and respect for equipment with minor or without guidance.

The 'average' category was the second-highest percentage, shows that some of the students in this range are able to organise and perform experiment well, but the percentage of completed the experiment is less than 81%. They may have skipped one or two steps/procedures while conducting the experiment and required minor guidance during demonstrating care and respect for the equipment.

It needs to be highlighted that 3.9 percent (PT1) and 1.3 percent (PT2) of the students were in the 'weak' category. These students were not able to conduct the experiment well during the practical test. They may have skipped more than three steps/procedures during demonstrating the experiment and need major help to demonstrate care and respect for the equipment. Some of the students were not able to recognise or choose the right apparatus required to conduct the laboratory test depends on the given problem. Lastly, for the 'poor' category, the contributions of the percentage were from the absent students during the practical test. Although this only applied to a minority of students, however, this is

an important issue need to be overcome as soon as possible. The lecturers need to give extra information and guideline to the students on laboratory activities to overcome the problems. Apart from that, the lecturers need to put more effort in conducting the lecture session or show a demonstration video to the students on how to operate the laboratory equipment.

Conclusion

Psychomotor domain is very important in teaching and learning, especially for engineering students. Assessment on psychomotor domain has been applied in many programmes including Basic Hydraulics courses of Diploma Programme in Civil Engineering (EC110) in Universiti Teknologi Mara. The implementation of methodology for this course has been described. The student's performance marks are divided into four categories; poor, weak, average and good. The analysis shows that more than 50% of students obtained a good category for both practical tests. However, there were a few numbers of students that achieved poor and weak categories. Hence, improvements should be considered to ensure student's performances are in good categories.

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