Measuring Students' Achievement in Fundamental Course of Civil and Structural Engineering Degree Programme

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Abstract: - Students' understanding in a fundamental course is important as it is a prior requirement before they can actually proceed to advance and specific courses in the degree programme. Without strong basic understanding, the students' ability to excel in their future studies may affect and indirectly chances of employability may also reduce. This paper describes the assessment and evaluation method used to measure the students' performance in the fundamental course of civil and structural engineering degree programme at Department of Civil and Structural Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM). The fundamental course of Static and Dynamics (KH 1044) was offered as a compulsory course for first year students in the department. The students' achievement is presented in terms of Course Outcomes (CO) and Programme Outcomes (PO) as aligned according to the Outcome Based Education (OBE). Based on this assessment, the results of the overall achievement of average percentage of COs for the course were above 50% except for CO5. These findings also proved that students' understanding in the fundamental course were acceptable and they managed to use the fundamental concept in solving any specific course of civil and structural engineering problem. However there are some aspects in teaching and learning process that can be improved and suggested from these findings.

Keywords: - course outcomes, fundamental course, outcome based education, fundamental concept.

1 Introduction

In 2003, Malaysia through the Engineering Accreditation Council (EAC) was admitted as a provisional member with the United Kingdom and Australia [1]. Since then Malaysia has shifted its engineering education system from the conventional prescriptive-based system to outcome based system. This requires engineering faculties in higher learning institute as well as accreditation body to focuses on the outcomes and long term objectives of the educational programmes. The emphasis towards this OBE is designed to ensure that the degree produce by the higher learning institute in Malaysia are recognized by the fellow Washington Accord (WA) member, such as United States, United Kingdom, Australia, South Africa etc. [2]. With the OBE implementation, our graduates will have a good opportunity to work in these countries.

In order to ensure that the engineering programs are substantially equivalent to the engineering degrees of the signatories of the WA, the OBE system must always be measured and evaluated. Thus in OBE approach, Programme Educational Objectives (PEO), Programme Outcomes (PO) and Course Outcomes (CO) must be identified and designed accordingly [3]. Each of the engineering courses must come out with the mapping of PO and CO and the achievement of these outcomes is very important as it will reflect the quality of the engineering programme as well as the students' ability. In this paper, the students' achievement in the fundamental course of Civil and Engineering Programme namely Static and Dynamics (KH 1044) was assessed and measured. Students' achievement in terms of COs of the course will be presented along with the related POs.

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Students' understanding in fundamental courses is very important as most of these courses are pre-requisite for any advanced or specific courses. Recent research indicates that despite high passing rates in most universities, most students do not understand their course content very deeply [4]. Students with strong understanding in fundamental courses will normally have no problems in continuing with the advanced courses. In fact students with strong basic knowledge in fundamental courses can easily solve any engineering problem given to them compared to those that always memorized the courses for examination purposes.

2 Methodology

The assessment and measurement of the course were conducted to all 51 students who have registered in first semester of session 2011/2012. The Static and Dynamics (KH 1044) course was selected because it has been identified as one of the fundamental course that offered for first year students in the department. Although there were other several fundamental courses available but strong understanding in static and dynamics course will enable students to apply this to the solution of practical engineering problems especially students in Civil and Structural Engineering Programme. To measure students' achievement and understanding towards the course, various types of assessment methods were carried out such as laboratory, tutorials, and examinations.

According to Le and Tam (2007) [5] study, a final examination can be considered as a deep learning approach which requires student understanding and logical thinking to obtain a pass. Through examination also students can gain sufficient knowledge and understanding on the relevant topics of the course and hence achieving a satisfactory grade. Thus for the assessment of the course, each assessment method was allocated with different percentage and the highest was mainly from the final examination. These assessment methods were measured based on the mapping of CO and PO as shown in Table 1. The COs and POs were prepared and shown to the students in the beginning of semester.

From Table 1, eight COs were assigned according to the syllabus of the course to match with the 10 POs used in the programme curriculum. However, the eight COs were related and contributed to only three POs as shown in the table. Generally, the approach in evaluating the achievement of CO was using existing data from students' marks or referred as formal assessment. The assessment methods used were grouped into; i) Final exam, (ii) Mid-semester exam, (iii) Tutorials, and (iv) Laboratory report. Each of these assessment methods has different overall percentage as shown in Table 2. Each CO will have its own 'mark' based on the percentage given. The 'CO-mark' was calculated based on the percentage of marks distribution for each assessment method.

Table 1 Mapping of POs and COs for Static and Dynamics (KH 1044)

No	Course Outcome (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	Delivery	Assessment
1	Able to apply and solve the basic concept of static and dynamic.	/										Class room instruction	Tutorial (assignment) and exam
2	Able to apply and solve engineering problem using force vector analysis, equilibrium equation for a particle and rigid body through engineering calculation.		/									Class room instruction	Tutorial (assignment) and exam
3	Able to analyze structure forces with method of joint and method of section, determine the internal forces and relationship with the shear force and bending moment diagram.		/									Class room instruction	Tutorial (assignment) and exam
4	Able to analyses and conduct experiment of structure forces and relationship of shear force and bending moment diagram .					/						Class room instruction and laboratory	Laboratory report.
5	Able to apply and solve the basic concept of dry friction analysis, center of gravity, centroid, moment of inertia and virtual work in engineering problems.		/									Class room instruction	Tutorial (assignment) and exam
6	Able to apply and solve the basic concept of kinematic of a particle with continuous and erratic motion.		/									Class room instruction	Tutorial (assignment) and exam
7	Able to apply and solve Newton's second law of motion for force and acceleration		/									Class room instruction	Tutorial (assignment) and exam
8	Able to apply and solve Newton's second law of motion and obtain the principle of work and energy, principle of impulse and momentum.		/									Class room instruction	Tutorial (assignment) and exam

Table 2 The overall percentage distribution

Assessment	Final exam	Mid-term exam	Tutorials	Lab reports	TOTAL
Overall percentage	45%	30%	10%	15%	100%

2.1 Laboratory assessment

For laboratory assessment, only CO4 was designed to measure the students' ability to analyze and conduct the experiment of structure forces and relationship of shear force and bending moment diagram. From Table 1, CO4 was linked to PO5 and the laboratory assessments were carried out based on two level of cognitive domain of Bloom Taxonomy which were application and analysis levels [6]. Experiments were carried out in group but students were still assessed individually. Assessment of the laboratory was mainly based on the technical report in which that they have to submit at the end of the laboratory class.

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2.2 Tutorials and examinations assessment

Almost all COs as shown in Table 1 were measured through tutorials, mid-semester and final examinations. From these assessments methods, the students' understanding in the fundamental course can be determined. Tutorials given to the students were assessed individually and they have to submit after two weeks from the date it were given. The level of assessment used in these tutorials and examinations were still based on the cognitive domain of Bloom Taxanomy [6] and it varies from level comprehension, application and analysis. It can be seen from Table 1 that the COs measured in the tutorials and examinations were linked to PO1 and PO2. Table 3 shows the list and description of each PO used in the course.

Table 3 List of POs Involve in KH1044

PO	Descriptions
PO1	Ability to acquire and apply knowledge of mathematics, science and engineering towards an in-depth technical competency in Civil and Structural Engineering/Civil and Environmental Engineering
PO2	Ability to undertake engineering problem identification, formulation and solutions
PO5	Ability to design and conduct experiment, as well as to analyze and interpret data

3 COs Achievements

Figure 1 shows the average percentage of eight COs achievement for the course. Almost all COs had achieved more than 60% except for CO3 and CO5. The assessment of both CO3 and CO5 were mainly from tutorials and examinations, thus it showed that students' understanding in these COs were acceptable but in some aspects can be considered as weak because these assessment tools were directly related to what students have learnt in class. Students' achievement in both CO3 and CO5 are very important as these outcomes are considered as the core knowledge in structural analysis. Students with weak understanding in these COs might have problem in continuing the advanced structure courses. It is also observed that CO4 has the highest average percentage of 80% and the marks for this CO were mainly assessed from laboratory work. Although the laboratory work was guided by demonstrator but the students have proved to have the ability to conduct the experiment and analyze the data of structural forces hence producing shear force and bending moment diagram. Figure 2 shows the percentage of students' number for each CO. In order to attain the CO, the student needs to obtain the score of 40% or more. It is observed respectively that 14, 10, 8, 2, 39, 4, 6 and 6 students did not achieve for CO1, CO2, CO3, CO4, CO5, CO6, CO7 and CO8 as shown in Figure 2. As a result, a continuous quality improvement (CQI) need to be determined to improve the achievement of all COs especially CO5.

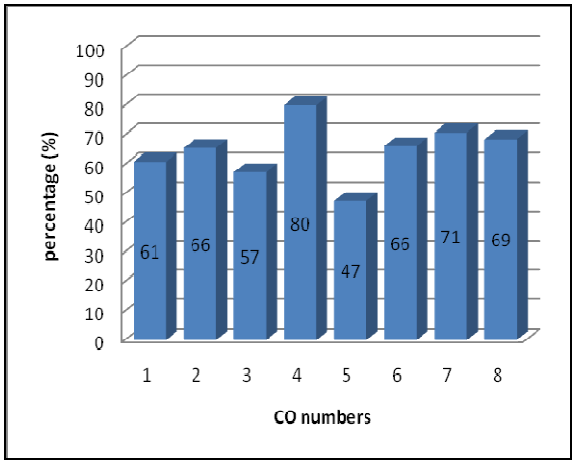

Figure 1 The average percentage of each CO

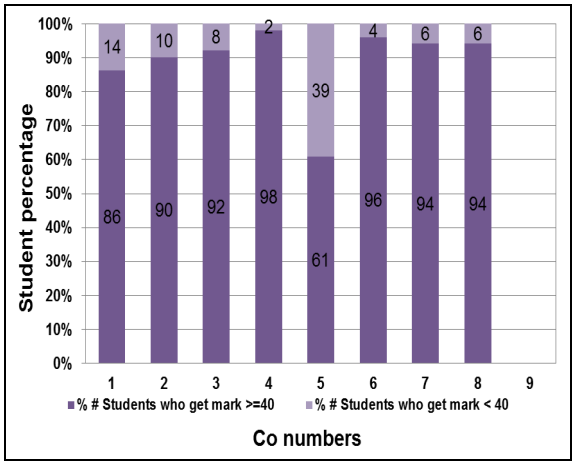

Figure 2 Students' percentage on each CO

In terms of POs analysis, the achievement of PO for the course can also be measured as only one CO is linked to one PO (refer to Table 1). Thus automatically the students' achievement in PO1, PO2 and PO5 can be determined as shown in Figure 3. From the figure, it is observed that PO5 has the highest percentage of 80% and it shows that the

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students' ability to design and conduct experiment as well as to analyze and interpret data are quite good. Whilst for the lowest percentage which is PO2 with 52% reflects the students' ability to undertake engineering problem identification, formulation and solutions are still weak. With these results, the following recommendations can be used to improve students' performance:

- Assigning more tutorials and examples in class especially for the important CO.
- Carrying out a small tutorial class or discussion group and this will help students to enhance their understanding.
- Creating more activities such as online tutorial to the students in order to increase their interest.
- Assigning more problem-based learning or small project for the important CO.

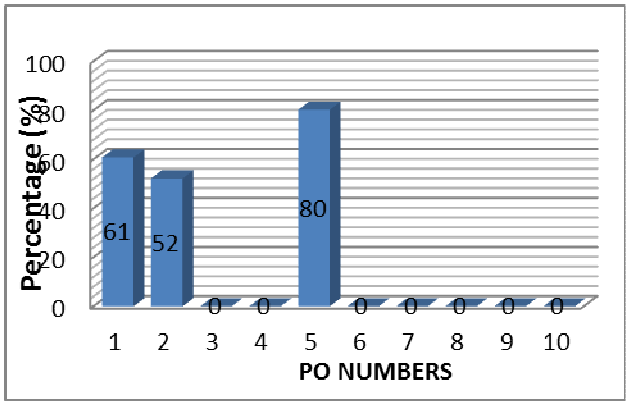

Figure 3 The average percentage of each PO

4 Conclusions

The results of this study indicate that the students' achievement for COs are quite acceptable as all COs have the average percentage above 50% except for CO5 and CO3 having the least average score since the assessment of these COs are only through tutorials and examinations. From these results also it has been found that the students' understanding in the fundamental course i.e static and dynamics (KH 1044) need to be improved as CO5 and CO3 which are the core outcomes is relatively low. However, for CO4 which is related to students' ability to analyze and conduct experiments have shown to be the highest score. This proved that the students are able to carry out the experiments and at the same time able to interpret and analyze the data within the stipulated time. Based on these findings, a proper and suitable teaching method must be carried out in order to improve their understanding and score marks in the fundamental course. This will eventually help students to score better marks in advanced structural courses. Useful recommendations have also been suggested for improvement of the course as well as for the students.

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