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INSIGHT JOURNAL
UNIVERSITI TEKNOLOGI MARA CAWANGAN JOHOR

Student Attaintment of Skill Sets Through Capstone Course in Diploma in Civil Engineering Programme

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Received Date: 5th July 2020
Accepted Date: 27th July 2020

ABSTRACT

Engineering education has become challenging compared to previous decade, the readiness of graduates before entering employement world is vital for the academician. Students are expected to possess all generic skill sets as needed by a qualified engineer including knowledge profile, engineering ability, communication, teamwork, and other relevant skills. In Malaysia, engineering graduates should possess 12 programme outcomes (PO) according to ETAC requirement, throughout the whole curriculum structure in diploma level. However, capstone course in Diploma Civil Engineering in UiTM only measures 3 main programme outcomes which are problem solving and scientific skills, communication skills, and ethics in engineering. The implementation of capstones course is reviewed for 3 consecutive semesters and student attaintment based on grade and programe outcomes is observed. This paper provides the assesment tools that had been mapped to programme outcomes through out 14 week lesson plan for final year students in Diploma Civil Engineering.This study was conducted in UiTM Pasir Gudang to measure the attainment of student's skill set based on programme outcomes stated in the syllabus. It shows that, a graduate is considered to be good in communication skills and ethics in engineering but average in problem solving skills and scientific skills. Thus, a few recomandations have been made to improve the skills attainment among students at the faculty level.

Keywords: *Civil Engineering, capstones course, student attainment.*

1.0 INTRODUCTION

Capstone course is a must for Diploma in Civil Engineering (EC110) to complete the 3 year-programme structure in Universiti Teknologi Mara (UiTM). Capstone courses are expected to sum up all the prior knowledge that was acquired in lower semesters. Civil Engineering Design Project has been chosen as a capstone course to fulfil the curriculum that meets the requirement of Engineering Technology Accreditation Council, ETAC. All graduating students will enrol the course in their last semester as specified in the programme structure provided by faculty. This course focuses on student self-centred approach to solve given tasks within 14 weeks of that semester, which covers reinforced concrete structure and steel structure. The task given is real engineering problem related to structural work and design process. The scope of the task is students should be able to design a building not exceeding two (2) storey building using reinforced concrete structure. In addition, students should be able to design simple structures for steel building such as elevated steel water tank and foot bridges.

At the end of the semester, students are expected to develop their skills in a set of problem solving and scientific skills, communication skills, and ethic in engineering. These three skills are mapped to the specified student assessment based on ETAC criteria. This study was conducted based on the examination that took place from Sept 2018 until July 2019 in the Universiti Teknologi MARA Cawangan Johor, Kampus Pasir Gudang. This paper is mainly to review the implementation of the capstone courses for EC110 students and their performance based on students grade and programme outcomes.

2.0 LITERATURE REVIEW

Capstone course is a normal exercise for numerous courses that are offered at tertiary level for engineering and non-engineering courses. Meanwhile, Thomas (2013) define capstone as a representation of final achievement that builds upon prior knowledge offered in lower semester in any curricula to integrate multi-disciplinary subjects. Bauer et al (2012) and Deepamala & Shobha (2018) conclude that capstone courses is an end journey of the curriculum programme of any courses that integrate knowledge from semester one to final semester. Meanwhile, Jones et al (2013) agreed with Deepamala & Shobha (2018), as they found that capstone course is usually designed as a self-directed course. Students will be independently working on their task and lecturers will facilitate the teaching and learning session instead of being a knowledge conveyor as a typical class lecturer.

As an end milestone, researches done by Jones et al(2018), Daria et al (2010),Iganacio et al (2010), Chandrasekaran et al (2012) and Majanoja & Vasankari (2018) found similar teaching approach for capstone study, normally applies problem-based learning. Capstone courses also incorporate technical knowledge based, engineering ability, and real-world problem solving with an emphasis on generic skills should be possessed by engineering graduates towards professional competencies. In addition, Jaime et al (2013) stated that exposing engineering students to real engineering problem will lead to first-hand experience and active learning environment that nurture the development of professional skills as part of their formal education at tertiary level before graduating. Besides that, Deepamala & Shobha (2018) revealed that capstone courses assess the students on their readiness for employment phase that requires them to conduct research, do effective documentation, managing project, and planning.

3.0 COURSE IMPLEMENTATION

Civil Engineering Design project is a studio orientated course where students are guided in performing design of structural elements of a reinforced concrete building and a steel structure, by integrating the knowledge gained from previous courses. This course requires students to pass two courses i.e. structure analysis and concrete and steel design in lower semester. Students will be given 1-hour lecture and 4 hours studio within a week in order to complete a task. The maximum number of students in a group is 4 persons and the assessment is based on individual progress work.

At the beginning of the semester, students will be briefed on the lesson plan for 14 week activities together with the tasks that should be completed within the time frame. For the first ten (10) weeks, students need to complete all tasks relating to reinforced concrete structure, consisting of analysis of loading, and preparing design calculation for slab, beam, column, footing, and staircase. All work checking must be performed using Eurocode 2 and design work is validated using software known as ESTEEM. Meanwhile, the remaining 4 weeks is to prepare design for steel structure that covers beam, column, and connections. Design checking should be done according to Eurocode 3. The assessment will be monitored on weekly basis depending on the tasks that have been assigned in each week.

3.1 Assessment of the courses

Student attainment will be measured based on common test, project presentation, project report and technical talk or site visit. Usually technical talk is

favourable compared to site visit due to the large number of students undertaking the course in a semester. The three assessments are measuring student's skill set of problem solving and critical thinking, communication skill, and ethics in engineering. Each assessment is mapped to the programme outcome as stipulated by the ETAC guidelines summarised in Table 1.

Technical report will be evaluated based on weekly progress as required by lesson plan. Students must submit each task as subdivide as mentioned in Table 2. The submission of the task will be considered as written communication skills as an output of the design process. Problem solving and scientific skills will be measured from a common test at the end of the semester, which carries the majority of the total marks. Both skill sets are developed through completing the weekly task and tested during the common test. Problem solving and scientific skills are considered to be more important compared to other skill sets for diploma students for them to develop their fundamental basic towards engineering knowledge. The faculty is also expecting students to be able to deliver the content of the project through oral presentation. The exercise imitates the real duty of an engineer that needs to communicate with public and other stake holders.

Table 1: Mapping of the Skill Sets Through Programme Outcomes

Assessment tools	Programme Outcomes	Skills set	Percentage assessment
Common test	PO3: Design solutions for well-defined technical problems and assists with the design systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental consideration	Problem solving and scientific skills	60
Project presentation	PO10: Communicate effectively on well-defined engineering activities with the engineering community and society at large, by being able to comprehend the work of others, document their own works, and give and receive clear instruction	Communication skill (Oral)	20
Technical talk/site visit	PO7: Understand and evaluate the sustainability and impact of engineering technician work in the solution of well-defined engineering problems in societal and environment context.	Value, ethics, moral and professional skills	10
Project report	PO10: Communicate effectively on well-defined engineering activities with the engineering community and society at large, by being able to comprehend the work of others, document their own works, and give and receive clear instruction	Communication skill(written)	10

Upon completing the tasks, all work must be compiled and printed as a hardbound report. The report should be submitted after getting feedback from panel during presentation. All assessments will be measured based on rubrics provided by faculty. Technical talk or site visit is conducted to prepare students for the real-world situations in the construction industry. Students must be exposed to typical design problems and construction failures on site or new development of construction industry. Activities such as these will allow students to capture the expectation of the industry towards engineering graduates towards ethics, moral, and professionalism in working environment.

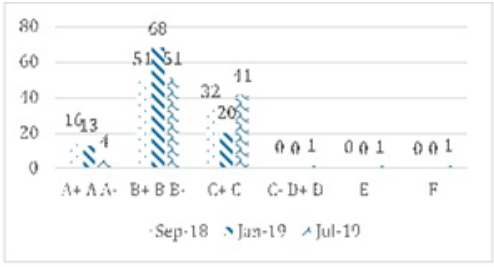
Table 2: Task distribution for 14 weeks lesson plan

Week	Project	Task
1-2	Reinforced concrete design	Introduction to the courses & finding architectural drawing from authorities, developer or any related company
3-4		Structural loading analysis for manual calculation and loading input into software
5		-Modeling of structure using computer software -Design of RC slab by manual
6-7 8		-Design of RC beam by manual - Software modelling - Design of RC column by manual -Software modelling - Case study
9		-Design of RC foundation by manual -Software modelling
10		-Design of RC staircase manually
11	Steel design	Steel beam design
12		Steel column design
13		Steel tension member design
14		Steel connection design

4.0 Discussion

A study had been conducted for three consecutive semesters i.e. September 2018, Jan 2019 and July 2019 in UiTM Cawangan Johor Kampus Pasir Gudang. The observation is based on student attainment on grade and programme outcome. Referring to performance criteria matrix provided by faculty, majority of our students are classified as good whereby more than 50% of students scored grade B+,B and B- as shown in Figure 1. Followed by, satisfactory grade which recorded student attainment is more than 20% for each semester while excellent grade is between 4% up to 16 %. However, there are students which fall under the category below average (D & D+) and weak (E &F). Students that fall under the two

categories are due to bad attitude and failed to complete the assessment provided by the syllabus. Meanwhile fluctuating percentage of the students' performance for each semester is due to student's entrance result for Diploma in Civil Engineering. The September batch and the July batch are considered the second batch and their entrance results are slightly lower compared to January batch which is the first intake students from Sijil Pelajaran Malaysia, SPM.



Grade	Performance Criteria matrix score
A+,A,A-	Excellent
B+,B,B-	Good
C,C+	Satisfactory
D+,D,D-	Below average
E,F	Weak

Figure 1 : Students performance based on grades and performance criteria matrix score.

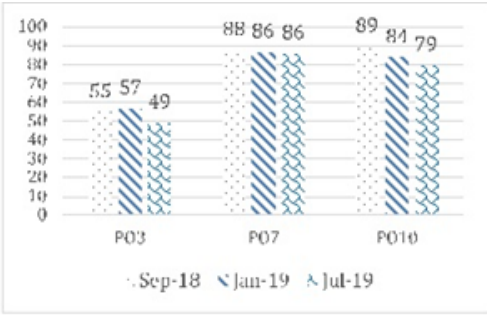
Based on Figure 2, students' score is excellent for ethics in engineering, where student attainment for PO7 is more than 85% for three consecutive semesters. It shows that students are attracted to the real problem happened in industry during technical talk or site visit. In addition, it also reflects that students are more concerned with the knowledge outside the classroom.

Students' communication skills, both written and oral, at diploma level can be considered good for all batches. PO10 achievement for this course is more than 79%. Therefore, graduates for EC110 are able to communicate well in English and also able to produce good report that consists of manual calculation and structural drawing.

However, problem solving and scientific skills among students are considered satisfactory and below average for July 2019 session. It shows that students are unable to complete the common test questions within 4 hour test due to:

- Content of the common test is too wide which consist of reinforced concrete structure and steel structure. Students need to study both designs which require different types of code of practice (Eurocode 2 & Eurocode 3).
- Large number of questions need be answered by students which require lengthy answer.
- Wrongly interpreted the questions that leads to irrelevant answer.

- Lower students' result entrance for culminating courses from lower grade may contribute to the lower attainment of the PO 3. Since this course is being park at the final year which requires prior knowledge from lower semester such as Basic Solid Mechanics (which having high failure rate), Basic Soil Engineering, Structural Analysis, and a few more courses.



PO Score (%)	Key performance indicator
80-100	Excellent
60-79	Good
50-59	Satisfactory
30-49	Below average
0-29	Weak

Figure 2: student attainment for program outcomes and scoring criteria.

Therefore, some changes should be done to overcome the problem regarding lower scoring of problem solving and scientific skills among students such as:

- Assessment tools for problem solving should vary instead of restricted for common test. The phase of changing the assessment tools can be done at faculty level by having curriculum review.
- Progress marks for manual calculations should contribute to PO3 since students are required to spend at least 4 hours per week to complete the task. Therefore, marks given will reflect the student's effort to complete the task.

5.0 Conclusion

Implementation of capstone course in Civil Engineering at diploma level is essential in fulfilling the requirement of ETAC for academic accreditation. Graduates are attracted to the real problem at the construction site and students are able to produce good communication skills at both oral presentation and written presentation. However, students are lacking in problem solving and scientific skills as shown in the average score of 50%. Something needs to be done to improve student attainment on problem solving at the faculty level. Students' fundamental basic on the entrance result to the programme should be restricted and assessment tools for problem solving should be revised through a curriculum review.

REFERENCES

Bauer, D. H., & Heier Stamm, J. L., & Strawderman, L. (2012, June). A Review of Capstone Course Designs Used in Industrial Engineering Programs Paper presented at 2012 ASEE Annual Conference & Exposition, San Antonio, Texas. 10.18260/1-2—20858.

Chandrasekaran, S., Stojcevski, A., Littlefair, G. and Joordens, M. (2012). Learning through projects in engineering education, in SEFI 2012: Engineering Education 2020: Meet The Future: Proceedings of the 40th SEFI Annual Conference 2012, European Society for Engineering Education (SEFI), Brussels, Belgium.

Daria, K. S., Daniel, K. & Gary, P. (2010).First-Year and Capstone Design Projects: Is the Bookend Curriculum Approach Effective for Skill Gain?. American Society for Engineering Education, 2010. Page 15.586.2

Deepamala, N., & Shobha, G. (2018). Effective approach in making capstone project a holistic learning experience to students of undergraduate computer science engineering program. Journal of Technology and Science Education, 8(4), 420-438. https://doi.org/10.3926/jotse.427

Ignacio, D. L. R., Adolfo, C., Jose, M.D.P., Jose, L.Y. (2010). Project Base Learning in Engineering Higher Education Two decades of Teaching Compentencies in real environmenents. Procedia Social and Behavioral Science 2, 1368-1378. DOI: 10.1016/j.sbspw2010.03.202.

Jaime, N. S., Sheila, L.F., Ivan, E. E., (2013). A Project based laerning approach for First year Engineering Courses. Innovation in Engineering, Technology and education for Compatitiveness and Prosperity. Elevent LACCEI Latin Amerıca and Caribbean for Engineering and Technology, Cancun Mexico.

Jones, B. D. , Epler, C. M. , Mokri, P. , Bryant, L. H. , & Paretti, M. C. (2013). The Effects of a Collaborative Problem-based Learning Experience on Students' Motivation in Engineering Capstone Courses. Interdisciplinary Journal of Problem-Based Learning, 7(2). Available at:https://doi.org/10.7771/1541-5015.1344.

Majanoja, A-M. and Vasankari, T. (2018).Reflections on Teaching Software Engineering Capstone Course. In Proceedings of the 10th International Conference on Computer Supported Education (CSEDU 2018) - Volume 2, pages 68-77 ISBN: 978-989-758-291-2.

Thomas A. Ward (2013). Common elements of capstone projects in the world's top-ranked engineering universities, European Journal of Engineering Education, 38:2, 211-218, DOI: 10.1080/03043797.2013.766676