Development in Teaching and Learning

Capstone Project to Satisfy EAC Criteria


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Abstract

Engineering Accreditation Council (EAC) has introduced eleven outcomes for engineering programs in Malaysia. Some of these outcomes are easily achievable and some are difficult to achieve through the traditional curriculum based education. This paper proposed a capstone project to provide learning experiences which may develop students’ ability in many of the EAC criteria. The students are grouped into 5-member teams. These groups were given a relatively sophisticated design project where the students would have to apply most of their knowledge and skills they accumulated during their learning experiences at UKM engineering program in order to carry out the design project. A two-stage cooperative learning method was adopted where in the first stage the students are grouped to develop expert panels. In this stage, each group was asked to study the problem and to find the best solution in a particular domain such as geotechnique, drainage, structure, foundation, environmental, water supply, sewerage or transportation. In the second stage, the students are regrouped such that each group would consist of experts for all the domains. The final result is that the students were able to provide an integrated design solution and they were able to explain their decisions effectively and confidently. This is the manifestation of their ability to work in a team, ability to communicate effectively, having in-depth technical competence in a specific domain, ability to undertake problem identification, formulation and solution, ability to utilise a systems approach to design, ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member, having the understanding of the social, cultural, global and environmental responsibilities and the need for sustainable development and ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. In addition, their ability to find the necessary knowledge and to apply the knowledge in their design project is preparing the students to recognise of the importance of life long learning.

Keywords: Cooperative Learning; Integrated design; Student ability

1. Introduction

Engineering Accreditation Council (EAC) has introduced 11 attributes in its latest accreditation guideline. Every higher institution to be accredited has to ensure that its graduates have all these attributes on the graduation day. During an accreditation process, a higher learning institution has to demonstrate that its curriculum, delivery methods and evaluation as well as its assessment have equipped all its graduates with all the attributes. For these purposes, Department of Civil and Structural Engineering, Universiti Kebangsaan Malaysia modified its existing curriculum and delivery method in 2002 to prepare itself for 2004 accreditation exercise. In the process, normal design project was transformed to become a capstone project to help students achieve several attributes out of the 11 attributes. In the project, the students, in 5 persons teams, are required to design a large complicated project. The project was chosen such that it includes all aspects of design in a civil engineering project.

2. Program Outcomes

EAC has published 11 generic attributes that has to be the outcomes of any engineering programs in Malaysia. In order to achieve the attributes and to have special attributes for civil engineering students, the Department of Civil and Structural Engineering has come up with 16 program outcomes (PO) as follows:

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3. The Capstone Project

Traditionally, individual student is given a design project at the last semester. Usually the project is a hypothetical, where its size and its complexity is designed to suite an individual student. In the past this kind of project was given to the students to train them to carry out structural design. The main drawback of this kind of project is that it did not train the students to design the project as a large system that requires several disciplines in civil engineering and interactions between the disciplines. In addition, it is the student individual project and because of that the project did not promote teamwork and leadership and did not give deep understanding about the real problem in design.

To achieve a more effective results, the project was transformed to become a capstone project that serves as a culminating focal point, encouraging students to tie together the knowledge, skills and abilities they have developed during their learning experience at the university [2]. In addition the project can be used to help the students to attain several more attributes if the adopted project has the following characteristics:

- Adequately large so as the project can only be solved by a group of students. This requirement is to train the students to have the ability to work in a team and good leadership quality (Attributes f and p).
- Adequately sophisticated so as the students have to use their fundamental knowledge and find more knowledge and information by themselves. This is to train the students to recognise the importance of lifelong learning (Attributes a, h and k). Also, the sophistication will force the students to use computer and modern software to solve the design problems in a more reasonable time frame (Attribute i).
- Consists of every discipline in civil engineering such as geotechnique, drainage, water supply, waste water, road network, transportation and structure. This is to train the students to design a project as an integrated system that consists of several specialised areas and to work in a multidiscipline team. (Attributes j and m).
- Real project with real problems of technical and non-technical in nature such as social, environmental and bureaucratic problems. This is to train the students to identify problems, to formulate the best solution and understanding social problems (Attributes d and g).

The students are expected to attained the above attributes provided with proper project selection based on the above criteria and with proper supervision. [3].

4. Cooperative Learning Component

Cooperative Learning is an effective active learning method. Several researches and studies have been carried out with convincing result that demonstrate Cooperative Learning is better in many ways compared to conventional teaching method [4].

The capstone project mentioned in this paper depends very much on the cooperative learning procedure. For the purpose of the project, the students are divided into a number of 5-member teams of mixed academic performance. Groups containing all weak students are likely to flounder aimlessly or reinforce one
another’s misconceptions, while groups composed entirely of strong students often adopt a divide and conquer policy, parcelling out and completing different parts of the assignment individually and putting the products together without discussion [5].

Transfer of knowledge between students are optimised by forming expert groups in the first stage and then the experts are distributed into working groups in such a way that each working group has at least one expert in each domain in the second stage of the project as shown in Figure 1.

Figure 1 Cooperative Learning Procedure

5. Practical Experience

Department of Civil and Structural Engineering has an enrollment of 400 students and every year about 100 students register for the engineering design project subject as part of the graduation requirement. The subject is introduced at final year and carries 3 credit hours. The department revised the subject into a capstone project in early 2003 and subsequently increase the load of the subject to 6 credit hours to reflect the students work load.

In the first stage, the students were grouped into 5-member teams to form the followings expert groups:

- Geometric design, platform level & earthwork
- Road, Traffic and Transport
- Sewerage, Drainage & Water supply
- Structure, Geotechnique and Foundation
- Economic Analysis & Environmental impact assessment

The students were given a new suburban development project that provide for 50,000 population and 60,000 square meters of commercial floor space. In such a large project, the students initially did not know how to go forward and how to apply their existing knowledge. After a total of 6 hours discussion among them, the students began to see some light and recognize to acquire extra knowledge to solve the design problems they were facing.

In the second stage, the students were regroups into several working groups where each group has to produce a complete integrated design of the project. For this reason, at least one expert in each domain has to be in each group. The major challenge in this stage is the design integration where every student in each group has to understand each other and be able to see the overall picture of the project. In this case, teamwork and leadership become very crucial in producing a complete overall design.

At the end of the semester, each group has to submit their design documents and drawings. Each group has also to present and defend the design in front of their colleagues. This procedure has improved the students’ communication skill (Attribute b).

6. Assessment

The assessment was more toward the achievement of the program outcomes which is based on the following criteria:

i. Ability to apply basic knowledge to solve real engineering problems (Achievement of PO a).
ii. Ability to present the project verbally and to produce a quality written report (Achievement of PO b).
iii. Ability to incorporate latest design method and materials in the design and design originality (Achievement of PO c, h, k, l and m).
iv. Ability to identify and consider all problems in the design (Achievement of PO d).
v. Ability to see the project as one system and to produce integrated design which reflects the quality teamwork (Achievement of PO e, f and j).
vi. Ability to incorporate all local authority requirements, environmental protection and consider social sensitivities in the design (Achievement of PO g and o).

Assessment of the course was carried out both directly and indirectly. A major portion of the assessment was based on direct assessment by four professional engineers scrutinising the drawings and the report produced by the student. Indirectly, peer and self assessments were also performed for triangulation purposes. In peer assessment, any one group was
assessed by other groups in the class. All assessments were in Likert Scale of 1 to 5. The summary results of the assessments are shown in Figure 2.

![Figure 2 Assessment Results](image)

The results indicate that the assessors were satisfied to the students ability in all assessment domains and so were the students and their peers. In assessing the student ability to incorporate the latest design method, the assessors gave higher score than the students themselves.

7. Conclusion

The capstone project and the way it was conducted, have contributed to the achievement of the Program Outcomes substantially. The achievement is not only in the design domain, but also in other domains especially in crucial soft skills such as communication, teamwork, leadership and life long learning skills.

References