Development of Professional Competencies in the CSED Curriculum at UKM

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Abstract

The engineering education today has been shift towards to prepare the engineers in meeting the needs of both public sector and private industry. They want the engineers to be technically skilful and also to be competent in a variety of professional practices that includes a variety of skills and outcomes i.e. communication, ethics, leadership, economics and creativity in order to be able to compete effectively in the global economy and many professional practice challenges. Civil and Structural Engineering Department (CSED) at the Universiti Kebangsaan Malaysia (UKM) has integrated professional practices into the curriculum to strengthen the students' technical knowledge and simultaneously become skilful communicators, team leaders, ethical engineers, creative thinkers, decision makers and problem solvers. In this paper, the experience of CSED, UKM in integrating the professional practices into the civil engineering courses throughout the four years programme is presented.

Keywords: Professional Practices; Engineering Education; Technical; Curriculum; Integrated; CSED.

1. Introduction

Efforts to improve undergraduate programme become systematic and coherent when the framework for an OBE was established at the faculty back in 2005 after Malaysia was admitted to the Washington Accord as a provisional signatory nation alongside Singapore and Germany [1]. A comprehensive methodology of combining technical and professional competencies (generic skills) sought by stakeholders such as the employers are implemented for OBE at UKM which is in line with the new philosophy adopted by both the Engineering...
Accredition Council and Malaysian Qualification Agency (MQA). In the Civil & Structural Engineering Department (CSED) at Universiti Kebangsaan Malaysia, the department has integrated the curriculum with the competencies to help CE graduates to prepare for their professional career.

2. Overview of Professional Competencies

Previous studies concluded that the definitions or list of the competencies are not universally accepted or agreed upon by the various professional bodies or stakeholder [2,3]. Since there are many competencies have been proposed and defined, hence this study only look into three sources that provide some insight of the competencies in relation to engineering education. Brief descriptions of these approaches to defining professional competencies are as follows;

2.1. The Organization for Economic Co-operation and Development (OECD)

Set of competencies defined are using language & technology interactively, acting autonomously, interacting in heterogeneous groups and ability to deal with complex situations in particular context [4]. The key competencies are needed in order for individuals to contribute for societies and himself/herself and help individuals meet important demands.

2.2. The Australian Council of Education Research (ACER)

ACER built their work partly on the Mayer competencies [5,6] presented employability skills i.e. self-awareness, self-promotion, exploring and creating opportunities, action planning, networking, matching and decision making, negotiation, political awareness, and self-confidence.

2.3. The Accreditation Board for engineering & Technology(ABET)

ABET have created two categories of competencies i.e a set of hard skills and a second set of professional skills. Six attributes of professional skills are ability to function multi-disciplinary teams, an understanding of professional and ethical responsibility, an ability to communicate effectively, able to understand the impact of engineering solution in a global, economic, environmental, and societal context, a recognition of the need for, and to engage in lifelong learning and a knowledge of contemporary issues [7].

3. Integrating Professional Practices into the CSED Engineering Curriculum

The latest curriculum structures of the CSED programmes have been introduced since 2010/2011 session. Subsequently, starting 2011/2012 session, new university courses have been introduced to improve further professional competencies development of the students. The balanced curriculum is reflected through distribution of courses through the minimum 4-year study period. The courses in the programme are arranged shown in Table 1 in such a way to strengthen students with the following knowledge and skills.

Table 1. CSED 4-year study programmes

| Cohort      | Attributes                                      |
|-------------|-------------------------------------------------|
| First year  | Fundamentals of engineering knowledge           |
| Second year | Development of engineering knowledge and skills  |
| Third year  | Development of engineering knowledge and skills  |
| Fourth year | Development and application of engineering skills and professionalism |
To achieve these attributes, Programme Outcomes (PO) that describes what students are expected to know or be able to do by the time of graduation is introduced and established. The initial POs for this programme were developed in 2005 with 12 POs. Further consolidation of twelve POs to 10 was made in July 2008. The 2008 POs are being established to acknowledge the level of domain, i.e. cognitive, psychomotor, and affective. The latest 10 POs are shown in Table 2. From Table 2, some POs have been identified to contribute to the achievement of professional competencies. The POs are PO2, PO4, PO7, PO8 and PO10.

Table 2. CSED Programme Outcomes

| POs | Statement                          |
|-----|-----------------------------------|
| PO1 | Engineering Knowledge             |
| PO2 | Problem Analysis                  |
| PO3 | Project Design                    |
| PO4 | Ethics                            |
| PO5 | Experiment Skills                 |
| PO6 | Engineering Techniques and Tools  |
| PO7 | Communication                     |
| PO8 | Teamwork                          |
| PO9 | Lifelong Learning                 |
| PO10| Project Management and Finance    |

4. Professional Competencies Addressed in the CSED Engineering Courses

A periodic meeting with Academic Advisors, Study Board and supervisor of the Industrial Training conclude that student needs an exposure to the professional practices, they have poor communication skill, lack skill in writing technical report, lack of confidence and hesitate to make a decisions. To address these deficiencies and promote additional professional practices, the CSED enhanced the CSED Engineering Programmes curriculum to integrate problem solving, communication skills, ethic, teamwork, leadership and project management into 17 CE and university courses shown in Table 3.
### Table 3 Mapping of courses and POs for CSED Engineering programmes

| Sem. | Code      | Course                               | PO2 | PO4 | PO7 | PO8 | PO10 |
|------|-----------|--------------------------------------|-----|-----|-----|-----|------|
| I    | HHHC9118  | Human Development                    |     |     |     | /   | /    |
|      | CMIE1022  | Fundamentals of Entrepreneurship and Innovation |     |     |     |     |     |
|      | KKKF1111  | Engineering and Built Environment Professionalism I |     | /   |     | /   | /    |
|      | KKKH1044  | Statics and Dynamics                 |     |     |     | /   | /    |
| II   | KKKF1121  | Engineering and Built Environment Professionalism II |     |     |     |     | /    |
|      | KKKH1124  | Engineering Survey                   |     |     |     |     |     |
| III  | KKKH2134  | Fluid Mechanics                      |     |     |     | /   | /    |
|      | KKKH2144  | Mechanics of Materials               |     |     |     | /   | /    |
|      | KKKH2164  | Civil Engineering Materials and Technology |     |     |     | /   | /    |
| IV   | KKKH2184  | Environmental Engineering Studies     |     |     |     | /   | /    |
|      | KKKH2254  | Geotechnics I                        |     |     |     | /   | /    |
| V    | KKKH3134  | Open Channel Hydraulics              |     |     |     | /   | /    |
|      | KKKH3154  | Geotechnics II                       |     |     |     | /   | /    |
|      | KKKH3284  | Reinforced Concrete Design           |     |     |     | /   | /    |
| VI   | KKKH3164  | Civil Engineering Construction and Management |     |     |     | /   | /    |
|      | KKKH3334  | Engineering Hydrology and Water Resources |     |     |     | /   | /    |
|      | KKKH3254  | Highway Engineering                  |     |     |     | /   | /    |

In order to ensure the students have acquired all the professional competencies, the POs are assessed by the lecturer, professional engineer from the industry and peer review. Students’ achievement is evaluated in a semester by examinations, problem sets, individual and group projects, laboratory assignments, problem-based learning (PBL), cornerstone and extended capstone design projects. Achievement in all of these areas is enhanced by presentations, laboratories, and problem-set and exam solutions. Figure 1 shows the achievement of the professional competencies through the POs performance result. The data used in the direct assessments of the achievement of the POs are obtained from all engineering core courses and general education and electives courses listed in Table 3. From Figure 1, PO8 (teamwork) has the highest student achievement. All the POs are
above 60% achievement except PO2 for student year 2. For this reason an improvement should be made for courses taught in Semester II to improve PO2.

5. Professional Competencies Integrate in the Student Co-curricular Activities

It is possible to acquire professional skills through adoption to existing courses in the programme. Not forgetting the fact that university courses and co-curriculum activities contribute to the development of students’ generic skills. Through extra-curricular activities, students have the opportunity to develop soft skills such as organization, communications, and management. The department also encourages and sponsors students to participate in educational competitions held internally and externally to promote self-confidence and self-esteem.

5.1. Contract Learning

Starting from 4th January 2011 (Semester 2, Session 2010/2011), all co-curriculum activities/project organised by student can be recognized as Credit Co-Curriculum based on Contract Learning (HHHC9118 Human Development). 8 learning outcomes that need to be fulfilled are social & responsibility, communication, information management & lifelong learning, value, attitude, ethic, & professionalism, critical thinking, problem solving & scientific approach, leadership & teamwork, management & entrepreneurship and creative & innovative.

5.2. Student Club

The faculty through the Engineering Student Society or Persatuan Mahasiswa Kejuruteraan (PEMATRA) has organized various activities for students. In order to organize activities that only involve the CSED’s student, a CSED’s Student Club was established in 2011. This is aimed to develop their interaction and social skills among themselves and to establish their leadership skills and working as a teamwork.

5.3. Educational Competition and Fair

The spirit of the competition had built up the team working fortitude in every aspect from the design process, construction, up to the competition part. The competition had also developed student’s creativity in design and was able to apply theoretical knowledge into practice.

6. Conclusion

The curriculum is balanced such that it comprises of various sub-disciplines of CSED. The courses in the programme are arranged in such a way to strengthen students with fundamentals of engineering knowledge, development of engineering skills and finally application of engineering knowledge and professionalism. Comments from the Academic Advisors, Study Board and supervisor of the Industrial Training conclude that the student need exposure to professional practices, have poor communication skill, lack skill in writing technical report, lack of confidence and hesitate to make a decisions. To address these deficiencies, the CSED enhanced the CSED Engineering Programmes curriculum to integrate the professional competencies i.e. problem solving, communication skills, ethic, teamwork, leadership and project management into 17 CE and university courses which are related to PO2, PO4, PO7, PO8 and PO10. The professional outlook is also can be acquired through student activities and the involvement of students with NGO professional bodies.
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